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RCR - A Danish textbook for courses in Responsible Conduct of Research [1. ed.]

Jensen, Karsten Klint; Whiteley, Louise Emma; Sandøe, Peter

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RCR – A Danish textbook for courses in Responsible Conduct of Research

Karsten Klint Jensen, Louise Whiteley
and Peter Sandøe (eds.)

RCR – A Danish textbook for courses in Responsible Conduct of Research

Editors: Karsten Klint Jensen¹, Louise Whiteley^{2,3} and Peter Sandøe^{1,4}

¹ Section for Consumption, Bioethics and Governance, Department of Food and Resource Economics, University of Copenhagen

² Medical Museion, Department of Public Health, University of Copenhagen

³ Novo Nordisk Foundation Center for Basic Metabolic Research (CBMR), University of Copenhagen

⁴ Section for Animal Welfare and Disease Control, Department of Large Animal Sciences, University of Copenhagen

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Department of Food and Resource Economics

University of Copenhagen

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1 About this book

Peter Sandøe, Karsten Klint Jensen & Louise Whiteley

1. Introduction

The Danish Code of Conduct for Research Integrity from 2014 recommends that all researchers receive teaching and training in the responsible conduct of research (RCR). Since 2011 it has in fact been mandatory for all new PhD students at the University of Copenhagen to take a course in RCR. PhD students in the Faculty of Science and the Faculty of Health and Medical Sciences take courses with the same content and roughly the same structure. For the first few years, course participants were given a compendium of texts to read. This involved inevitable overlaps and a lack of terminological consistency. In addition, many of the texts originated in the US, where the regulatory framework on RCR differs from that found in Denmark. A number of the people involved in teaching the two courses have therefore joined forces to produce a more complete, consistent and concise text. The present book is the result of this initiative.

The aims of this book are thus to give an accessible presentation of what PhD students are supposed to learn about RCR; to present clear and consistent terminology; and to focus on the way RCR is dealt with in Denmark and at the University of Copenhagen. The intended readers are from two faculties where the great majority of research projects fall under the umbrella of the natural sciences, broadly construed. This book therefore talks about ‘research’ as typically understood and practiced in the natural sciences. Researchers from the social sciences or humanities may not always feel comfortable with the way we describe research, but we hope that this text will inform the reflections of students from all disciplines – many of the issues are shared across disciplines, and identifying where they differ can also be illuminating. We also hope that PhD supervisors and other researchers will find the book useful, in part as a common meeting point for discussion between students and their supervisors.

So we had a course that needed a textbook, but why have the course in the first place? In other words, what do we hope to achieve by teaching the subjects presented here? This is the first question we will address in this brief introductory chapter. Then we will consider the scope of the textbook, and finally we will say a little about the book’s structure and use.

2. Why RCR teaching?

The immediate reason that the University of Copenhagen became the first university in Denmark to introduce mandatory RCR courses for all PhD students was a scandal that hit the university in 2010. This scandal involved Professor of Biomedicine Milena Penkowa and centered on alleged research misconduct dating back about 10 years. It prompted various critiques of the top management of the University and the Faculty of Health and Medical Sciences for not responding in a timely and adequate manner to a number of warnings over the years (read more about this case in Ch. 3).

Following the scandal a number of initiatives were taken, first at the University of Copenhagen and later nationally, to prevent research misconduct and promote RCR. The first of these initiatives was

to require courses in RCR for future researchers, i.e. PhD students. Requirements for RCR teaching have since been expanded to cover PhD supervisors and students at BA and Masters level.

This raises the question: Are mandatory courses in RCR an efficient means of combating research misconduct? Will they prevent cases like that of Milena Penkowa in future? The short answer is “no”. Cases of serious scientific dishonesty seem to have occurred at regular intervals historically and are often closely linked to the personalities and specific circumstances of the researchers involved. There is every reason to think that such cases will continue to occur.

What then is the point of the course? First, it may provide people with the knowledge and tools to deal in a more timely way with cases of serious dishonesty when they do occur. Even though mandatory courses in RCR would be unlikely to have prevented the Penkowa case, they could have enabled university management and concerned fellow scientists to effectively investigate and deal with the case at a much earlier stage. Secondly, it is important to underline that although a case of serious research misconduct was the immediate reason for establishing the course, RCR also focuses on the wider and much more common issue of the grey zone between research misconduct and perfectly virtuous scientific standards. In other words, on the everyday issues all researchers face.

For instance, authorship issues play a very important role in RCR, but only in serious cases would they constitute research misconduct. Questions about authorship include: Who should be co-authors of a publication? How should the order of the authors be decided? Who should play the role of corresponding author? In which ways should co-authors be consulted before the final version of a paper is submitted? What kind of information and/or documentation is required concerning the contributions of the respective authors? It is important for all PhD students to be clear about the answers to these questions, particularly those whose theses are composed of journal articles. If authorship issues are not managed well, authorship disputes, delays in publication of the work, or detraction from its scientific quality, can result. However, most such issues constitute Questionable Research Practices (QRP, see Ch. 2) rather than serious research misconduct.

It is our hope that the course teaching sessions and this textbook will smooth the journey through a research career for young scientists; that they will become better at dealing with authorship issues as well as other key areas where questionable research practices occur, such as data management, intellectual property rights, conflicts of interest, and communication with a wider public. It should also be noticed that Danish researchers are not alone in having to learn about RCR. Researchers in countries such as the US have for some years had to pass exams in RCR to hold federal grants and to be appointed to faculty positions. Moreover, knowledge of the field of RCR principles, reflection, and regulation is increasingly required as part of international research collaboration.

3. The scope and limits of this textbook

In some cases there are clear principles of responsible conduct that students should know: for example, that you must obtain the explicit consent of all co-authors before submitting a paper. But in many instances we cannot give clearly defined answers as to the right way to behave. This is not

because, as the authors of this publication, we are uninformed or vague; rather it is because there are grey zones where rules and established norms do not give clear answers. For example, as will become clear in Ch. 4, there is no precise, objective and universally applicable rule setting out what it takes to qualify as a co-author. There are minimum requirements, including making a substantial contribution to content, though what it means for a contribution to be “substantial” is itself difficult to define and differs across disciplines, institutions, and research groups.

Where clear rules and guidelines cannot be given, we instead aim to enable the reader to become better at reasoning about the issues; to find her or his own stance. This is a critical part of learning to be a scientist, but it is often conducted ad hoc, in private, and alone. We hope to contribute to a growing climate of openness about what it is to be a responsible researcher, and about the boundary between acceptable shortcuts and irresponsible conduct.

The area of RCR is not static – quite the contrary. What is considered good practice is constantly shifting. Take, for example, data management. Until recently there were no rules about how researchers at the University of Copenhagen should keep and share research data. Now the different faculties are developing detailed rules and policies, and international norms regarding data sharing are developing rapidly. Another aim of the course and this textbook is therefore to inform researchers about recent developments, whilst also encouraging them to keep themselves up to date.

It should be noted that some subjects that are typically covered by RCR courses in other countries are not covered here. In particular, ethical issues surrounding the use of human subjects and animals in research are dealt with by existing, obligatory courses for researchers working in these fields.

4. The content and structure of the book

Following this introductory chapter we provide a general framework for understanding the idea of RCR, and how it has developed and been institutionalized.

Chapter 2 describes how interest in RCR has developed since the 1980s, starting in the US and then spreading across the world. Key terminology relating to RCR is then described and defined. Most importantly, we explain the distinction between *Research Misconduct* and *Questionable Research Practices*, where the former is fraudulent research behavior involving *Falsification*, *Fabrication* and *Plagiarism*, and the latter covers the many ‘grey zone’ issues.

In Chapter 3 we discuss how the regulation of RCR has developed in Denmark and specifically at the University of Copenhagen. We explain how a number of dramatic cases of scientific misconduct spurred the development of a series of institutions and codes: the Committees for Scientific Dishonesty, the University of Copenhagen Committee for Good Scientific Practice, the Named Person, and the Danish Code of Conduct for Research Integrity. We conclude the chapter with an overview of how to handle issues in responsible research conduct.

The remaining five chapters cover a number of specific issues we consider likely to be of relevance to young researchers:

In Chapter 4 we look at issues raised by publication and authorship which, as argued above, are central to being a researcher. In Chapter 5 we deal with another issue that most readers will have faced, i.e. data management. In what way and for how long should we store research materials and data, and when and how should we share them with other researchers? In Chapter 6 we look at an issue that is a mandatory part of the course but will be relevant only to some readers, i.e. patenting and other forms of commercialization of research results. In Chapter 7 we discuss conflicts of interest. Financial conflicts of interest should be considered by all researchers who are funded by, or collaborate with, industry. But potential conflicts of interest are not just financial; they span every stage of the research process, where pressures on researchers' time and productivity can undermine responsible research conduct. In the final chapter we look at communication between science and the wider society, discussing why, when, and how public science communication work should be undertaken. This subject may seem a little remote for some PhD students, and it is primarily a responsibility of the institution rather than of each individual researcher; but even researchers who decide not to get involved in public communication are required to write a popular piece based on their thesis which may be quoted by media sources.

Each chapter starts with a summary. Information about rules, institutions and some cases are placed in text boxes, and links to useful documents and further reading are included. Finally, at the end of each chapter there are "test yourself questions", which in some cases remind you of the key points and in others encourage you to consider complexities which may not have a simple answer.

The subjects covered by this book are developing all the time. We therefore foresee regular updates and hope that our readers will give us feedback that can be used to improve future versions. Comments can be sent to Karsten Klint Jensen at kkj@ifro.ku.dk or Louise Whiteley at lowh@sund.ku.dk

2 General introduction to Responsible Conduct of Research

Karsten Klint Jensen¹

Summary

This chapter describes how the focus on research misconduct developed, first in the US and later elsewhere in the world, through a number of spectacular cases. It goes on to ask why researchers engage in misconduct, and this leads to a short discussion of the modern institution of science. The competitive nature of contemporary science incentivizes not only serious misconduct, but also much more widespread questionable research practices. The chapter concludes by describing recent initiatives to promote research integrity, internationally as well as in Denmark

1. Introduction

Box 1: Wakefield and the vaccination scare

In 1998, the British medical doctor Andrew Wakefield together with 12 co-authors published a study in the journal *The Lancet* of 12 autistic children in which they suggested a possible link between the triple MMR (measles, mumps, rubella) inoculation and what they identified as a new autistic syndrome. Before the paper was published Wakefield called for the suspension of the MMR vaccination program at a press conference. This fueled an MMR vaccination scare, which eventually led to a decline in vaccination rates in the US, the UK and Ireland; and the paper, and Wakefield's later warnings, encouraged general mistrust of all forms of vaccine. However, other studies failed to reproduce Wakefield's findings. In 2007 a hearing began to examine charges of misconduct against Wakefield and two of his co-authors, and in 2010 the 1998 paper was declared dishonest because it involved deliberate falsification of data. This led to a retraction of the paper by *The Lancet*. Although he claimed to be innocent, Wakefield was then barred from practicing in the UK. However, he continued to do research in the US, and to this day he defends his claims and continues to warn against the MMR vaccine. It is believed that the vaccination scare is responsible for serious illness and deaths in thousands of children.

Research misconduct may have serious consequences for patients or consumers, who may experience harmful effects from a treatment or a marketed product which is made available on the

¹ This text grew out of a draft by Hanne Andersen ("Responsible Conduct of Research: Why and How?", *RePoSS: Research Publications on Science Studies*, 29, Aarhus: Centre for Science Studies, Aarhus University (2014)). The author is grateful to Hanne Andersen for permitting her text to serve as source for the present version with the minor overlaps this might involve. Thanks are also due to Peter Sandøe and Mathias Willumsen for valuable comments.

basis of false and misleading information in the name of science. Alternatively, as happened in the Wakefield case (see Box 1) individuals may suffer as a result of not using a product having been exposed to fraudulent claims about negative effects that were made in the name of science. In the larger picture, the worry is that science as an institution may lose credibility, and as a consequence diminish in importance, and leave society open to more irrational decision-making.

Fueled by some spectacular cases, there has been a gradually increasing focus on promoting *Responsible Conduct of Research* (RCR). This development started in the US, but it has now spread across the world. Most countries have thus set up regulation for institutions to deal with cases of *research misconduct*, a category generally defined internationally by the three notions *Fabrication*, *Falsification*, and *Plagiarism* (FFP, see more below). Within the scientific community the importance of promoting responsible conduct of research has also increasingly been acknowledged in order to discourage far more widespread questionable research practices which may not amount to serious misconduct but nevertheless threaten the integrity of science. Thus a number of international and national codes for *research integrity* have been formulated.

Responsible conduct of research and its failure, i.e. research misconduct and questionable research practices, have developed in this process into notions which no researcher can afford to ignore. This is not only because of the potentially disastrous consequences for society of research misconduct, but also because of the possible negative consequences for the individual researcher, and for the scientific community, of engaging in questionable research practices.

Thus, in the wake of the Penkowa case, the University of Copenhagen found it necessary to increase its focus on how to deal with deviations from RCR by, among other things, setting up mandatory courses for PhD students and senior researchers in responsible conduct of research. A similar tightening up has occurred at universities all over the world, and many journals are now enforcing stricter requirements which authors must meet.

The need for training in RCR is underpinned by the fact that in many cases it is not clear where the line should be drawn. Between the clear cut cases of responsible conduct, on the one side, and clear cut cases of research misconduct, on the other, there is a grey zone of *questionable research practices* with vague boundaries where it is often unclear where to draw the line. It is therefore necessary for researchers to understand the concepts on each side which delineate this grey zone, and to reflect on the implications for personal behavior in order to navigate prudently in the area.

This chapter gives a general introduction to RCR. It will define and describe the concepts of *research misconduct* and *questionable research practices*, and the concepts of *responsible conduct of research* and *research integrity*, and place them all in context.

2. What is Research Misconduct?

Box 2: The Soman case

In 1978, Helena Wachslicht-Rodbart submitted a manuscript to *New England Journal of Medicine*. One reviewer, Professor Philip Felig of Yale, passed on the paper to his junior, Vijay Soman, and they recommended rejection. However, two other reviewers recommend acceptance subject to revision. During her work on the revision Wachslicht-Rodbart was asked by *The American Journal of Medicine* to review a paper written by Soman and Felig. The paper looked very similar to her own. Some paragraphs and an equation were identical, and it appeared that the authors had been the very people to recommend rejection of her own paper. Wachslicht-Rodbart complained about plagiarism to *New England Journal of Medicine*, and she also expressed doubts to Yale about whether Soman and Felig had conducted a study at all. However, no investigations were initiated. On the contrary, all parties seemed to prefer a quiet cover-up; even her superior, who happened to be an old friend of Felig's, tried to shut her up and threatened to dismiss her. The Soman-Felig paper was published, but new problems with the paper appeared, and finally an investigator was appointed. Soman then admitted to have fabricated the data and agreed to resign. Further investigations uncovered fraud in 12 other papers by Soman, most of which had Felig as co-author. Felig was fired from a prestigious newly taken position at Columbia, but returned later to Yale. Wachslicht-Rodbart decided to leave research.

The case illustrates several aspects of research misconduct. For one thing, there appears to be great resistance to accepting that a scientist has engaged in fraud on purpose. The prestige attached to certain persons or positions, or the prestige invested in promoting certain researchers or results, typically adds to this difficulty.

Secondly, research misconduct concerns not only the individual researchers involved, but also the institutions at which they work, and the journals in which they publish. There might be a temptation to conceal a case of research misconduct, or to make light of its importance, or even to shoot the whistleblower in order to protect the university or journal from negative publicity. However, once a cover up is revealed, the university or journal itself will lose credibility.

Universities were traditionally viewed as self-regulating academic communities; and until the 1980s it was more or less left to universities themselves to deal with cases of research misconduct and questionable research practices. No universities had formal systems for doing this. Even in a very serious case like the Soman case described in Box 2 it was often a long while for before the affected university reacted by setting up ad hoc investigations; and along the way the whistleblower, which in the Soman case was a young scientist without a permanent position, was often treated very badly.

However, during the 1970s and 1980s, several spectacular cases of misconduct in the US painted a wider picture of incidents similar to the Soman case. The perceived tendency was that, in many cases, institutions appeared to close their eyes in the face of fraud to protect old friends and discredit whistleblowers. Where investigations were initiated they appeared to be dragged out for

very long time and not to reach clear verdicts; and in many cases perpetrators were able to continue in their questionable practices at other institutions. The cases appeared to show to the public that the scientific community itself was unable to deal effectively and convincingly with cases of research misconduct.

In 1981 the first of a series of congressional hearings threw light on the problems and placed increased pressure on institutions to set up systems to deal with cases of research misconduct, and to teach staff and students norms of responsible conduct of research. In the late 1980s, despite protests from the scientific community, the US was the first country to implement regulations that required universities receiving public funding to establish clear policies and procedures for handling misconduct.

Hence, a system developed in the US in which the main universities and other leading research institutions set up rules for RCR and appointed people to deal with offences. At the same time the main funding agencies, like the National Institute of Health and the National Science Foundation, set up offices, such as the Office of Research Integrity, to follow and coordinate action. Also during this period the leading journals in medicine and science gradually developed codes of conduct for responsible authorship and started to retract papers based on documented research misconduct (cf. the Wakefield case described in Box 1).

Thus, the first definition of misconduct was provided by the US misconduct regulations. Their current definition is known as the FFP definition, because it focuses on Fabrication, Falsification and Plagiarism (see Box 3).

Box 3: US Office of Research Integrity definition of Research Misconduct

Research misconduct means fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.

(a) *Fabrication* is making up data or results and recording or reporting them.

(b) *Falsification* is manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.

(c) *Plagiarism* is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit.

Research misconduct does not include honest error or differences of opinion.

<http://ori.hhs.gov/definition-misconduct>

Of course, the US was not the only country to encounter problems with research misconduct which called for regulation. Similar developments have occurred in many other countries and have spread from the medical sciences to social science and the humanities.

Box 4: The Hwang Woo-Suk case

Hwang Woo-Suk is a South Korean researcher who became known as the King of Cloning. He appeared to be the answer to the South Korean hope of achieving industrial progress through biotechnology in spite of limited investments and a rather narrow scientific base. Based on his claim to have cloned some cows (but without providing verifiable data), media hype about the great promise of his research developed. He became a central person within a strong national network in South Korean science governance and attracted a lot of Government funding. After Hwang's team claimed to have obtained stem cells from one out of thirty human embryos (published in *Science* 2004), and later, that it had established 11 embryonic stem-cell lines derived from the skin cells of individual patients (published in *Science* 2005), Hwang became the pride of South Korea. When the Bioethics and Biosafety Act came into force January 1, 2005 it contained a clause that effectively exempted Hwang from the regulation.

Ironically, Hwang was charged with unethical conduct for having used eggs from paid donors and a junior member of his team. He admitted this and resigned, but he intended to continue his research. The Seoul National University opened an investigation into his research which concluded that both *Science* papers were based on fraudulent data. *Science* retracted the two papers, and Hwang was later sentenced to two years in prison (suspended) for embezzlement and bioethical violations. Apparently, he is still active as researcher.

This case emphasizes the international character of much research, which also means that misconduct may have consequences all over the world. It also shows, like the Wakefield case, how hype about expected results can create strong expectations not only among patients and other potential end-beneficiaries, but also among funders. Apparently, strong expectations may create incentives to cheat in order to deliver. Experience of success and hero status also seem to impair otherwise ordinary critical perspectives.

Box 5: The Diederik Stapel case

Diederik Stapel is a former Dutch Professor in social psychology. At the height of his career he was considered a star at Tilburg University, and he was famous for several outstanding publications on human behavior. However, three young researchers started to wonder about his practices, and eventually a committee was set up to investigate his work at three universities in The Netherlands. He was suspended in 2011.

The final report (2012) concluded that Stapel had fabricated or manipulated data for at least 55 publications, dating back to as early as 2004. Early in his career, he manipulated data, but later he simply made up complete experiments and sent data to colleagues or PhD students for further analysis. No one was ever allowed to see the raw data. In all 19 PhD theses were prepared with data from Stapel, but the investigators advised that the PhD degrees should not be retracted, because Stapel had acted alone with the fraud.

In 2013, Stapel agreed to perform 120 hours community service and to give up income from his former position (at 1.5 x annual salary) in order to avoid further criminal prosecution.

The Stapel case is an example from the social sciences. It shows the importance of openness in handling data and of access for others to raw data. Once again in this case, a senior researcher's success and status were instrumental in silencing critical questions for very long time. Maybe there is an indication here that fear of losing status may be an even stronger temptation to cheat than the original gain of advantage without costs. The case also illustrates the importance of an environment with general openness about procedures, and with ample space for questions and critique.

Box 6: The Annette Schavan case

Annette Schavan is a German politician and member of the Christian Democratic Union. She studied education, philosophy and catholic theology and earned her doctorate at Düsseldorf University with a dissertation entitled *Person and Conscience*. In 1995-2005 she was minister for culture, youth and sport in Baden-Württemberg, and in 2005-2013 she was federal minister for education and research.

In 2012 the blog <https://schavanplag.wordpress.com/> claimed that Schavan's dissertation contained 94 out of 325 pages which were copied without any references. Schavan asked the university to examine the allegation. In an interview, Schavan said that she could not claim not to have made mistakes out of carelessness, but she could claim not to have plagiarized or even cheated. However, the faculty concluded in 2013 that, throughout the dissertation, she had willfully committed fraud by plagiarism, and her degree was revoked. Schavan announced immediately that she would file a complaint over the verdict to the Court of Administration (Verwaltungsgericht). A few days later, she stepped down as minister.

Her complaint was rejected in 2014. But in the same year she received an honorary doctorate from the University of Lübeck, and later in 2014 she became German ambassador to the Vatican.

This is a case from the humanities. It is a case with many ironic perspectives. A person who writes about the way conscience is formed, and about how conscience is necessary in education, is not troubled by her own conscience when it comes to plagiarizing others in her own education. Also, as minister she was responsible for research integrity across the entire country, with her own integrity somewhat impaired. Finally, research misconduct apparently does not matter for your respectability, as a Catholic, in representing your country to the Catholic Church itself. But apart from that, it seems that Schavan herself and many people in her circles do not take plagiarism very seriously.

Initially, the US definition of misconduct contained, in addition to fabrication, falsification, and plagiarism, a fourth clause: "other practices that seriously deviate from those that are commonly accepted within the scientific community". However, this clause was criticized by many scientists, including the National Academy of Science, because it could be used to punish creative or novel

science. It was therefore later removed, and the US regulations now include only fabrication, falsification and plagiarism in their definition.

The fact that research misconduct does not include differences of opinion has been explicitly confirmed in Denmark. This happened as a result of the case against Bjørn Lomborg (see Ch. 3). However, in contrast with the US definition, which only mentions FFP and excludes “honest error” from research misconduct, Denmark, like many other countries in Europe and Australia, has adopted a wider definition. The Danish definition (termed ‘scientific dishonesty’) is open-ended; it includes a clause on “other serious violations of good scientific practice” and also includes acts that are “grossly negligent”. There is a detailed description of the Danish system in Ch. 3.

National differences in regulation may create problems for researchers participating in the international world of science, since what is declared research misconduct in one country may not be so declared in another.

3. The competitive nature of the current institution of science

Why do people engage in misconduct? The many spectacular cases of misconduct have forced the scientific community not only to set up institutions and procedures to handle cases of misconduct, but also to look at the causes. It seems to be a general pattern that the motive behind research misconduct is to gain a self-interested advantage “without incurring the cost of effort” (Fang and Casadewall (2013)) in the competition for funding, positions and overall recognition.

Back in 1942, the sociologist of science Robert C. Merton tried to describe the values adhered to by the scientific community (Merton 1973); he identified what later became known as the CUDOS norms: Communalism (new results are the common property of the scientific community), Universalism (scientists can all contribute to science regardless of their race or gender or social background), Disinterestedness (scientists are not driven by personal interests in their pursuit of science), and Organized Skepticism (scientific claims are critically scrutinized by the scientific community before being accepted). Merton’s description contributed widely to the scientific community’s perception of itself.

Interestingly, Merton did not attribute the norm of disinterestedness to the scientific community because he believed scientists to be morally better than ordinary people; rather, in spite of their not being so, he found that the frequency of severe fraud in science is lower relative to the level of fraud in other areas. He concluded that an institutional norm is active in preventing scientists from research misconduct. However, the norm of disinterestedness, in Merton’s understanding, could also be violated by misusing science for various political purposes (e.g. in claims about race or history).

At the end of the twentieth century the physicist John M. Ziman described the institution of science rather differently using the PLACE norms (Ziman 2000): Proprietary (results are proprietary rather than communal), Local (researchers focus on local puzzles rather than general understanding), Authority (there is a hierarchical structure of authority rather than the equality implied by Merton’s universalism), Commissioned (research is often commissioned and therefore not disinterested), and

Expert (scientists are valued as experts who can give advice on action rather than for their originality; ‘originality’ later became included in the CUDOS norms).

Clearly, these differences signal a dramatic development over the intervening years in the perception of how science works, how it is organized and how it relates to society. And this raises questions about how science, as an institution, can retain its integrity if the traditional norms as described by Merton are challenged to such a large extent. However, a closer look at the actual development gives a more nuanced picture. Some points will be highlighted in the following.

One aspect of the development is the *mere increase in volume*. Already in 1963, the historian of science Derek John de Solla Price argued in his book *Little Science – Big Science* that the amount of scientific activity, measured by the number of journals and results etc., had been growing exponentially, doubling every 10-15 years (Solla Price 1963). Even if, as he warned, this growth cannot proceed indefinitely, expansion has continued to this date. Just to mention one thing, a recent study, following up on Solla Price, on the number of journals (Olesen Larsen & von Ins, 2010) concluded that “[t]here are no indications that the growth rate has decreased in the last 50 years”.

Another aspect is the increasingly prominent *role in society* which science has gained during the twentieth century and the first 15 years of the twenty-first century. Especially after WWII, science-based inventions and technologies made it clear to both politicians and the general public alike that science had the potential to create prosperity and solve problems for society on a large scale. Also, society has come to expect that ‘expert’ scientific knowledge will guide governments, public and private agencies, and individual citizens in making informed decisions on almost any issue in modern life, from dietary choice and medical treatment to energy saving initiatives and computer safety.

With the high expectations about what advances in science can bring, governments all over the world allocate substantial amounts of money to scientific research. Public agencies for the funding of scientific research to the benefit of society have thus been created in many countries, and later also internationally, most notably perhaps in the EU. Thus, publicly funded research has increased enormously in recent decades, and countries around the globe allocate a substantial share of their resources to science. Similarly, governments spend large amounts of money on the education of academics.

Spending so much money on science, governments expect returns from their investment. In order to optimize quality and the efficient use of resources, many governments allocate large parts of public research funding through free competition between applicants. Moreover, many governments have encouraged collaboration and co-funding between universities and industry, hoping to see greater economic returns from research investment. As a result, researchers have become much more dependent on proving scientific success, not least in terms of publications, and they increasingly engage in research activities with partners from the private sector where financial and other interests may conflict with the traditional values of academic freedom and disinterestedness.

Another development, sometimes described as the move from Mode 1 to Mode 2 Research,² is the funding of large, temporary, interdisciplinary projects designed to address specific problems. These problems are defined, not by academia (as in Mode 1), but by a wider group of stakeholders in society, among them often representatives of industry. Contemporary research is also characterized by greater internationalization, typically encouraged by funding agencies in the hope that synergies across borders may increase the quality of outputs and promote capacity building.

In order to meet the demands of governments and other funders, it has been necessary to organize science in large units with a high degree of specialization and division of labor. Moreover, the large temporary consortiums that are needed for successful applications for international funding of interdisciplinary projects also place strong demands on organization.

Overall, these developments have no doubt led to higher scientific standards and more rigorous methods. Current requirements on clinical trials and statistical rigor are important examples of this. Also, the increasing demands for honesty and accuracy in reporting have halted practices which big scientific names in the past managed to get away with into something which now would be characterized as research misconduct.

Clearly, however, the developments also raise some challenges. The modern scientist has left the ivory tower and has become member of ordinary society. Funders of research make strong demands on researchers, and getting funds from a variety of sources, including private industry, places the modern scientist in a field of conflicting interests that have to be managed. Conflicts of interest are discussed in more detail in chapter 7. Increasingly, patents are the expected outcome of such collaborations, which means that some scientific results are no longer common property. The issue of Intellectual Property Rights (IPR) is discussed in chapter 6.

Also, scientists are not only providing the public good of shared knowledge; they are also involved in fierce competition for funding and positions. With such keen competition, researchers are highly dependent on proving their continued success in performance. Since most funders take various bibliometrics (e.g. journal rankings and citation indices) as their shorthand for assessing quality in scientific performance, researchers perceive an increasing pressure to publish as much as possible, as quickly as possible, and in as high-ranking journals as possible.

The competitive environment provides an incentive for each individual to gain advantages relative to others; and in this climate some people are likely to be tempted into misconduct.

4. Questionable Research Practices

How widespread is research misconduct? Clearly, this is difficult to assess accurately as underreporting is very likely. Martinson et al. (2005) report estimates ranging from 1% to 2%. These figures indicate that very many cases go undetected when compared to the number of reported cases. Thus, institutions and procedures need to be in place to handle the cases. Moreover,

² These terms were coined in 1994 by A Gibbons et al. in *The new production of knowledge: the dynamics of science and research in contemporary societies* (Sage).

universities need to develop a culture which provides access and protection for whistleblowers and at the same time offers protection from false accusations, which may also be part of a competitive environment.

However, while strict research misconduct probably remains within the range of 1-2%, what are known as *questionable research practices* are much more widespread. These are understood as research which can undermine research integrity without amounting to research misconduct (FPP). In Denmark, research integrity has been summarized under the headline features of honesty, transparency and accountability (cf. the Danish Code of Conduct for Research Integrity, and see more in Section 5 below); questionable research practices are breaches of RCR but those that are not serious enough to amount to research misconduct. Clearly, questionable research practices are not sharply defined, but examples include problems within some of the areas discussed later in this book, like authorship and publication (chapter 4), data handling and management (chapter 5) and conflicts of interest (chapter 7).

Some people wish to bring failure to live up to accepted standards for scientific methodology under the concept of questionable research practices. For instance, there has been a recent debate on reproducibility in science, which evolved in the medical sciences but is likely to spread to other areas. There is evidence to suggest that much basic and clinical research does not fulfill the fundamental requirement of reproducibility (e.g. see Begley & Ioannidis 2015 and <http://www.thelancet.com/series/research> for further discussion). Failure of reproducibility is, of course, a very serious problem. But it is controversial to include it in questionable research practices as these are described above. Scientific standards develop over time and this does not in itself render earlier research breaches of honesty, transparency or accountability. Hence, these questions are kept apart in this chapter.

On the basis of a meta-analysis of available studies of the prevalence of research misconduct, Fanelli (2009) found that almost 2% of researchers admitted to having “fabricated, falsified or modified data or results at least once” (p. e5738), while 33.7% admitted other questionable research practices. When participants were asked about the behavior of their colleagues, the numbers rose, and 14% reported that they had witnessed colleagues engaging in falsification and 72% reported that they had witnessed colleagues engage in questionable research practices.

To the extent that questionable research practices (in the narrower sense) are much more widespread, they may have serious consequences. Given society’s strong dependence on science, both society and the institution of science are vulnerable when science goes astray. Thus, an understanding of questionable research practices is important.

Table 1 Percentage of scientists who say that they engaged in the behaviour listed within the previous three years (n = 3,247)			
Top ten behaviours	All	Mid-career	Early-career
1. Falsifying or 'cooking' research data	0.3	0.2	0.5
2. Ignoring major aspects of human-subject requirements	0.3	0.3	0.4
3. Not properly disclosing involvement in firms whose products are based on one's own research	0.3	0.4	0.3
4. Relationships with students, research subjects or clients that may be interpreted as questionable	1.4	1.3	1.4
5. Using another's ideas without obtaining permission or giving due credit	1.4	1.7	1.0
6. Unauthorized use of confidential information in connection with one's own research	1.7	2.4	0.8 ***
7. Failing to present data that contradict one's own previous research	6.0	6.5	5.3
8. Circumventing certain minor aspects of human-subject requirements	7.6	9.0	6.0 **
9. Overlooking others' use of flawed data or questionable interpretation of data	12.5	12.2	12.8
10. Changing the design, methodology or results of a study in response to pressure from a funding source	15.5	20.6	9.5 ***
Other behaviours			
11. Publishing the same data or results in two or more publications	4.7	5.9	3.4 **
12. Inappropriately assigning authorship credit	10.0	12.3	7.4 ***
13. Withholding details of methodology or results in papers or proposals	10.8	12.4	8.9 **
14. Using inadequate or inappropriate research designs	13.5	14.6	12.2
15. Dropping observations or data points from analyses based on a gut feeling that they were inaccurate	15.3	14.3	16.5
16. Inadequate record keeping related to research projects	27.5	27.7	27.3
Note: significance of χ^2 tests of differences between mid- and early-career scientists are noted by ** ($P < 0.01$) and *** ($P < 0.001$).			

Figure 1: A table indicating how prevalent various behaviors are in the US (from Martinson, Anderson, & De Vries (2005))

Martinson et al. (2005) distributed a survey among several thousand US researchers (see Figure 1). The “top ten behaviors” here are behaviors that are likely to be sanctionable. The “other behaviors” are less serious or careless.

Martinson and his colleagues found that 0.3 % of the scientists who replied to the survey had, by their own admission, engaged in the falsification of data, and that 1.4 % had used the ideas of others without obtaining permission or giving due credit (plagiarism). However, a number of behaviors extending beyond FFP had far higher frequencies. Thus, 6% had failed to present data that contradicted their own previous research, 12.5% had overlooked others’ use of flawed data or questionable interpretation of data, and 15.5 % had changed design, methodology or results in

response to pressure from a funding source. Bias in the face of pressure from funding will be treated in more detail in Ch. 7.

The frequencies of some of the “other behaviors” are alarmingly high. Some of these will be treated in more detail later in this book: authorship and publications issues are examined in chapter 4, and the handling and storage of data in chapter 5.

Each of these behaviors has the consequence that certain results look more credible than they really are. People who make decisions based on perceptions of such overestimated credibility may be misled into problematic courses of action. Also, scientists who base their research on false confidence in others’ results may waste their time; they are even at risk producing further errors.

Another aspect of such behaviors is that they result in certain researchers “improving” their credentials in the competition for funding, positions, and so on. Martinson et al. (2005) suggest that this may amplify questionable practices because people who see others appearing to get away with questionable practices without sanction (and who therefore see a skewed distribution of positions, publications and funding) may be tempted to adopt questionable practices themselves in order not to lose out in the competition in an environment they do not trust to be fair anyway.

Considerations such as these suggest that research misbehaviour is not just a matter of individuals with “bad traits”, or of local contexts (departments, laboratories) with a “bad culture”. Widespread questionable research practices appear to be associated with more general institutional and structural features of the research environment. This has gradually led to a stronger focus on general research integrity.

5. Research Integrity

The notion *responsible conduct of research* refers to conduct that conforms with certain rules or guidelines. This notion looks at behavior from the outside, so to speak: do the individuals perform the right actions? Do they, for example, report findings accurately and objectively?

Research integrity is a notion which stresses the importance of the underlying values and norms which the whole research community should not only display in behavior, but internalize as ideals they believe in, and in so doing become motivated to comply with rules and guidelines. Scientists and scientific institutions should take responsibility for the trustworthiness of their research.

Within the last decade, agencies around the globe have worked towards international dialogue on how to understand and promote research integrity and to eventually harmonize standards and regulations.

A series of World Conferences on Research Integrity, from 2007 onwards, has been prominent in this work. The 2nd World Conference in 2010 produced the [Singapore Statement on Research Integrity](#) as an international statement which outlines “the principles and professional responsibilities that are fundamental to the integrity of research wherever it is undertaken”. These are summarized as:

- *Honesty in all aspects of research*

- *Accountability in the conduct of research*
- *Professional courtesy and fairness in working with others*
- *Good stewardship of research on behalf of others*

This statement was followed, at the 3rd World Conference, by the 2013 [Montreal Statement on Research Integrity in Cross-Boundary Research Collaborations](#), which outlines the responsibilities of individual and institutional partners in cross boundary research collaborations, including general collaborative responsibilities, responsibilities in managing collaboration and in collaborative relationships, and responsibilities for the outcomes of research.

Together the statements acknowledge that there are many national and disciplinary differences in the way research is organized and conducted, but they aim to formulate basic principles and professional responsibilities that are fundamental to the integrity of science in general terms. The detailed interpretation of the general principles and more specific legal implications, however, are often spelled out in more detail in national and local regulations.

The various existing Danish guidelines all refer to these international statements. In a collaborative operation initiated in 2013 the Ministry of Higher Education and Science and the organization Universities Denmark worked together on [The Danish Code of Conduct for Research Integrity](#), which was published 2014. These guidelines now serve as the primary point of reference in Denmark, and they will have to be implemented by the universities, at which point they will be elaborated into more detailed policies.

According to the code, three basic values should guide all research (see Box 7):

Box 7: The Danish Code of Conduct for Research Integrity

Principles of Research Integrity

Honesty

To ensure the trustworthiness of research, researchers should be **honest** when reporting objectives, methods, data, analysis, results, conclusions, etc.

This requires accurate and balanced reporting when:

- presenting and interpreting research
- making claims based on findings
- acknowledging the work of other researchers
- applying for research funding
- reviewing and evaluating research

Transparency

To ensure the credibility of scientific reasoning and to ensure that academic reflection is consistent with practice in the relevant field of research, all phases of research should be **transparent**.

This requires openness when reporting:

- conflicts of interest
- planning of research
- research methods applied
- results and conclusions

Accountability

To ensure the reliability of research, all parties involved should be **accountable** for the research carried out.

This requires that researchers and institutions accept responsibility for the research they are conducting, in terms of:

- accuracy and reliability of research results
- adherence to all relevant regulations
- fostering and maintaining a culture of research integrity through teaching, training, and supervision
- taking appropriate measures when dealing with breaches of responsible conduct of research

The code goes on to specify in detail the responsibilities of individuals and institutions across a wide range of areas including research planning and conduct, data management, publication and communication, authorship, collaborative research and conflicts of interest. It also outlines principles for research integrity in teaching, training and supervision. Finally, it states: “Institutions and researchers share a responsibility for addressing and taking appropriate measures when encountering breaches of responsible conduct of research”, and this includes research misconduct as well as the broader range of questionable research practices. It seems reasonable to end this chapter with the statement: “**Researchers** and **institutions** are responsible for creating and maintaining an environment where it is acceptable to bring forward well-founded suspicions of breaches of responsible conduct of research in good faith.”

This helps to bring out the idea of an overall responsibility to create an environment for research in which the incentives to indulge in questionable practices are minimized because individuals perceive the system as fair and it is hard to gain unfair advantages without costs to oneself.

Details of the way to cases of breaches of responsible conduct of research in Denmark should be handled follow in chapter 3.

6. Test yourself questions

- How do “research misconduct” and “questionable research practices” differ?
- What are the main reasons why people engage in scientific misbehavior?
- How do “responsible conduct of research” (RCR) and “research integrity” differ?
- What are the basic values underlying research integrity?

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Guidelines:

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<http://www.researchintegrity.org/Statements/Montreal%20Statement%20English.pdf>
- The Danish Code of Conduct for Research Integrity (2014),
<http://ufm.dk/publikationer/2014/filer-2014/the-danish-code-of-conduct-for-research-integrity.pdf>

3 How are breaches of RCR handled in Denmark?

*Peter Sandøe & Mathias Willumsen*³

Summary

This chapter describes Danish procedures for handling breaches of RCR as they have developed over the years and explains how researchers encountering problems with RCR can navigate their way through the system. The following institutions, regulations and official recommendations are covered by the chapter: The Danish Committees on Scientific Dishonesty, the University of Copenhagen Committee for Good Scientific Practice, Named Person arrangements, and the Danish Code of Conduct for Research Integrity.

1. Introduction

What can and should you do if you come across colleagues or collaborators who engage in scientific practices you find problematic? In cases where you decide that this is a situation where you need to act, what are the possibilities and where can you seek guidance? The answers to these questions should to a large extent depend on answers to the following further questions: What systems are set up in Denmark to deal with research misconduct, breaches of responsible conduct of research, and questionable research practice? And what official rules and norms apply to these systems? These are the questions that we will address in this chapter.

Over the last few decades, following the developments in the US described in chapter 2, most other Western countries have set up systems to deal with research misconduct. Most countries have followed the model in which primary responsibility for investigating and dealing with allegations of scientific dishonesty lies with the individual research institution. However, in Denmark, a system for dealing with cases of research misconduct at the *national* level was developed from the start of the 1990s. This system was later supplemented with procedures for dealing with less serious cases of improper scientific practice at university level. Since 2012 this has been further supplemented with a system with so-called “Named Persons” who serve as the point of contact for researchers and students who are unsure about how to handle alleged cases of research misconduct or questionable research practice.

In the following we shall describe the Danish system for handling violations of RCR as it has developed over the years, and we shall try to give advice on how a researcher facing problems regarding RCR can use the system. The starting point of this is a presentation of the Danish Committees on Scientific Dishonesty. The body from which this group of three committees developed was first established in 1992, and today the Committees are still the backbone of the system for handling cases of alleged research misconduct in Denmark.

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2. The Danish Committees on Scientific Dishonesty – outline of the system

The committee system grew out of an initiative taken by the Danish Research Council for Medical Sciences. At first a committee of eight members, of which seven were medical scientists, and the last, the chair, was a high court judge, was established in 1992. This committee covered health and medical sciences only and was established as a temporary initiative. In many ways it served to define the later terms and workings of the system.

In 1998 a permanent system with three committees covering the full spectrum of scientific enquiry was established by an executive order issued by the Minister of Higher Education and Science. (This system is currently based on *Consolidated Act No. 1064 of 6 September 2010 on the Research Advisory System, etc.* passed by the Danish parliament). This meant that from 1998 onwards the Committees had a foundation in Danish legislation, and that the definition of scientific dishonesty was now laid down in law. For a reference to the current rules, see Box 1 and Box 2; and for a description of the 1998 rules see the 1999 report issued by the Danish Committees on Scientific Dishonesty (in Danish) at: <http://ufm.dk/publikationer/2000/filer-2000/beretning-1999.pdf>.

The three committees in existence today are divided into health sciences, natural science and engineering and, finally, social science and the humanities. The same high court judge chairs all three committees to ensure consistent treatment of cases across them. The other members must be recognized scientists from the relevant research areas. All the scientific members of the Committees are appointed by the Minister based on a hearing in the Danish Council for Independent Research. In cases dealing with cross-disciplinary research the Committees may collaborate.

Box 1: The Danish Committees on Scientific Dishonesty (DCSD)

The DCSD is a national system for handling cases of scientific dishonesty operating under the Ministry of Higher Education and Science. The term ‘scientific dishonesty’ is the Danish equivalent of what is referred to internationally outside Denmark as ‘research misconduct’. However, to “Falsification, fabrication, plagiarism” the Danish definition currently adds the clause “and other serious violations of good scientific practice committed willfully or grossly negligent” (see Box 2).

The committees deal with written complaints about scientific dishonesty. They cannot punish offenders but may inform the institutions to which the offenders are attached and the institutions may then invoke disciplinary actions.

For more information see: <http://ufm.dk/en/research-and-innovation/councils-and-commissions/the-danish-committees-on-scientific-dishonesty>. Here it is also possible to read anonymized decisions taken by the Committees.

For an overview of the current regulatory framework see: <http://ufm.dk/en/research-and-innovation/councils-and-commissions/the-danish-committees-on-scientific-dishonesty/regulation-for-the-dcsd>

The starting point of a case is normally that someone files a written complaint. A complaint can be filed by an individual person or an institution. The Committees can raise cases at their own initiative. However, this does not happen in practice, and hence the Committees normally do not “police” and investigate cases at their own initiative. As a result cases are in practice reliant on someone being willing to come forward and make the complaint. The name of the person who makes the complaint will be issued to the person(s) complained about; and the system therefore does not allow for anonymous whistleblowers.

In most cases a complaint will be about alleged scientific dishonesty by another researcher. However, sometimes cases are also raised by researchers who want to be cleared of allegations of scientific dishonesty against themselves. This happened, for example, in 1994 when the newly elected rector of the University of Copenhagen, Kjeld Møllgård (these were the days when rectors were elected by university staff and students), faced allegations of scientific dishonesty going back more than 20 years to a time when he was conducting a study at the University of California, Berkeley. In this case the committee, based on a report from a subcommittee with external members, concluded that the allegations against Møllgård were baseless.

The wording describing what counts as scientific dishonesty has changed since the rules for the first committee were defined, but the substance is more or less the same – see Box 2 for the latest version.

Box 2: The Danish definition of Research Misconduct (termed Scientific Dishonesty)

Executive Order on the Danish Committees on Scientific Dishonesty

Executive Order No. 306 of 20 April 2009, Section 2:

Scientific dishonesty shall mean: Falsification, fabrication, plagiarism and other serious violations of good scientific practice committed willfully or grossly negligent on planning, performance or reporting of research results. Included hereunder are:

1. Undisclosed fabrication and construction of data or substitution with fictitious data.
2. Undisclosed selective or surreptitious discarding of a person’s own undesired results.
3. Undisclosed unusual and misleading use of statistical methods.
4. Undisclosed biased or distorted interpretation of a person s own results and conclusions.
5. Plagiarism of other persons’ results or publications.
6. A false credit given to the author or authors, misrepresentation of title or workplace.
7. Submission of incorrect information about scientific qualifications.

When a case is submitted to the Committees, the first thing they do is decide whether or not to deal with the case. For the Committees to accept a case it must fall under the remit of the Committees on Scientific Dishonesty as defined by the rules referred to in Box 1. A number of formal requirements must then be satisfied. First, the person concerned must be trained as a researcher in the scientific area that the complaint concerns, the complaint must concern a written research product or an

application for funding from a public research grant, and the research product or application must have a relation to research carried out in Denmark, research carried out by persons employed in Denmark or research carried out with Danish public funding. Research conducted at private companies without public support is not covered by the rules, unless the private institution agrees to have the case considered by the Committees.

Secondly it must be a case of alleged scientific dishonesty, not just a scientific disagreement. Right from the start of the committee system, a distinction was drawn between scientific disagreement over the validity of scientific theories, or the quality of the research being conducted, and claims about scientific dishonesty. The Committees only deal with the latter. Disagreements about what constitutes good science and the validity of specific scientific claims are left for the scientific community itself to deal with through peer review and the publication of critiques of others' work.

So, in essence, three requirements must be met for an act of a researcher to be deemed a case of scientific dishonesty:

- 1) It must be a case of falsification, fabrication, plagiarism or some other serious violation of the norms of good scientific practice.
- 2) It must be done willfully or with gross negligence.
- 3) It must be about a written product produced as part of the planning, carrying through or reporting of research related to a Danish public institution or based on public funding.

Many of the cases put before the committees are rejected at the initial phase when the third of these conditions is applied, typically because they do not concern a written scientific product. For example, if a researcher engages in a public debate and makes claims that are not supported by facts this is usually not covered by the rules.

When a case is taken on it is assigned to the committee dealing with the field of research in question. If the case is complicated and requires expertise not found among the members of that committee, it may be decided that an ad hoc group should be set up, sometimes with external experts, to review the case. In other cases, the Committees may obtain an external statement from an expert giving an opinion on (parts of) the case.

The next step is to initiate a consultation procedure with the parties to the case. The person (or persons) being complained about will receive the complaint and a request to submit comments to the Committees. This allows the person complained about to give her or his version of the story. In cases where the committee hearing the case has decided that an ad hoc group should be set up, or has obtained an external statement, the person will also be informed about the composition of this group or the content of the statement. The complainant will then receive a response from the person being complained about and be given a chance to comment. The complainants' comments will be sent to the person complained about who will be given a final opportunity to reply to the Committees.

After this, the case is investigated by the committee. In the process of investigation more material than that originally submitted with the written complaint and provided by the person complained about during the hearing process may be asked for. If the material contains factual information, the parties will be given an opportunity to comment on the information.

Where the Committees reach a preliminary decision that scientific dishonesty has occurred, they send a draft decision to the parties for comments before they make the final decision. If the Committees find that scientific dishonesty has not occurred, they give a final decision without consulting the parties. In Box 2 below is a sketch of a case dealt with by the Committee on Scientific Dishonesty involving natural science and engineering.

Box 3: A case of scientific dishonesty handled by the Danish Committees on Scientific Dishonesty (DCSD)

“The DCSD were contacted by a Danish university which filed a plagiarism complaint. A member of a hiring committee, set up for recruiting candidates for a scientific position, suspected that an applicant had enclosed an article which the applicant had not written. The hiring committee confirmed its suspicion by tracking down the original article.

The complaint was processed by the Committee on Scientific Dishonesty for Research in Natural, Technological and Manufacturing Sciences (UNTPF).

In connection with the hearing of the facts in the case, the respondent admitted having enclosed an article which he had not written but had supplied it with his own name. In this connection, the respondent stated that the plagiarised article should be regarded as a test of whether the university was sufficiently thorough in its processing of applications for scientific positions.

The UNTPF did not find the respondent’s argument to be credible and found the respondent to exhibit dishonesty by intentionally plagiarising the results of others and wrongfully alleging to be the author of a scientific publication which the respondent had not written ... “

The case can be retrieved at the 2009 annual review of the activities of Danish Committees on Scientific Dishonesty, see: <http://ufm.dk/en/publications/2010/files-2010/the-danish-committees-on-scientific-dishonesty-annual-review-2009.pdf>

This case was simple. Others are much more complicated – they are often protracted and last years as the result of, among other things, numerous hearings and complaints from the parties.

In recent years there has been, on average, around one case a year where a researcher has been found to be scientifically dishonest. As pointed out above, the Committees are not able to punish offenders, but they can do a number of things which may have serious consequences for the person deemed dishonest. The main thing they can do inform the person’s employer if the person is employed as a researcher. Using this information, the employer may choose to apply sanctions, the most drastic of which would be to terminate the person’s employment. Also, if the case concerns an application for a grant from a public funding body, the Committees may inform the funding body that a conclusion of scientific dishonesty has been reached. Furthermore, the Committees can inform public authorities who supervise the area in question.

In the case described in Box 3 the effects on the convicted researcher are likely to have been minimal. Since the decision is only made public in an anonymous form, the name of the researcher

will not be publicly known, and the case will therefore not affect the person's possibility to apply for future jobs. However, the activities of the Committees fall under Danish legislation on access to public information, so the press and other interested parties may seek access to non-anonymized versions of the committees' decisions. The researchers most affected by a verdict of scientific dishonesty are those who already have a name, and hence a reputation that can be badly damaged when it is found out that they have been involved in scientific dishonesty. A bad reputation may, among other things, affect the researcher's ability to attract funding and limit her or his invitations to give lectures at conferences and the like.

So it is no small thing for an established researcher to be found guilty of scientific dishonesty. This is why the Committees are headed by a high court judge, and why safeguards in the form of hearings are in place. In many cases the Committees reach a conclusion that scientific dishonesty has not occurred, either owing to lack of evidence or because the practice involved, although questionable, does not qualify as scientific dishonesty.

In the first ten years the Committees on Scientific Dishonesty operated a practice developed whereby they could reach the conclusion that a person was not guilty of scientific dishonesty but was still open to criticism for questionable research practice. In this way the system was to some extent able to deal with "grey zones". However, this came to a dramatic end in 2003, following the case of Bjørn Lomborg.

3. The Lomborg case and the establishment of Committees for Good Scientific Practice at university level

In 1998 Bjørn Lomborg who was then Associate Professor at the Department of Political Science, Aarhus University, published a series of short popular papers in the Danish newspaper *Politiken* in which, in a polemical tone, he accused many of the scientists dealing with environmental risks of overstating the case and creating unnecessary fear. He also claimed that many of the solutions offered to deal with environmental problems were not optimal from a cost-benefit perspective. Later he turned his ideas into a book, which appeared, in 2001, in an English translation, *The Skeptical Environmentalist*, published by the prestigious academic publisher Cambridge University Press. His ideas and arguments had a wide uptake both in Denmark, where in 2002 he was made the director of the newly established Environmental Assessment Institute, and internationally, where he was widely acclaimed for his contribution to the environmental debate.

Many of the scientists accused of scaremongering by Lomborg were not happy, and some of them reacted by writing critical responses to Lomborg's claims and arguments. Thus Lomborg's views and arguments gave rise to a huge debate which took place both in popular media and in scientific circles. For example, the *Scientific American* invited four experts to comment on different aspects of *The Skeptical Environmentalist*, and these comments were then responded to by Lomborg.

A number of the frustrated scientists also reacted at the start of 2002 by filing three separate complaints against Lomborg to the Danish Committees on Scientific Dishonesty. Here it was claimed that in *The Skeptical Environmentalist* Lomborg was guilty of, among other things,

falsification of data, of deliberately misleading use of statistical methods, and of the deliberately skewed representation of other people's scientific findings.

From the start the allegations gave rise to disagreement among the members of the Committees who discussed them at a joint meeting for all three committees in June 2002. Some members believed the case should be rejected at the initial phase because, as they saw it, *The Skeptical Environmentalist* was not a research publication and therefore did not meet the third of the three requirements listed above. Other members disagreed, and in the end a decision was made to establish an ad hoc group consisting of members from all three committees to look at the complaints.

The working group delivered its report in September 2002. The report mainly presented the rather harsh comments on *The Skeptical Environmentalist* made by other scientists in *Scientific American*. It also referred to a number of very defamatory statements about Lomborg made by prominent scientists in an issue of *Time Magazine*. Furthermore, it criticized Lomborg for publishing his controversial claims in popular or semi-popular media rather than in papers for international journals with peer review. Finally, the report claimed that it was not in accordance with the norms of good scientific practice for a researcher to communicate research results to a wider public before these results have been reviewed by scientific peers.

On the question of whether *The Skeptical Environmentalist* could be considered a research publication, the working group delivered a divided decision. This disagreement continued when the report from the group was discussed at two joint meetings for all three committees in the autumn of 2002. However, an agreement was reached not to simply dismiss the complaints on the grounds that the work complained about was not a scientific publication.

In the final decision, which was accepted unanimously by the members of all three committees, it was decided that Bjørn Lomborg satisfied the first of the three requirements of scientific dishonesty in that his book misrepresented the scientific content of the studies reviewed to such a degree that it could be classified as a case of falsification. However, the committee members also agreed that it was not possible to prove that the falsification was willful or grossly negligent, so the second requirement for a case to count as one of scientific dishonesty was not fulfilled. At the same time the committee chose to leave the question whether *The Skeptical Environmentalist* should be classified as a product of research open.

On this basis the Committees decided on the following wording of their decision: "*Objectively the publication falls under the concept scientific dishonesty. Viewed in light of the subjective requirements regarding willfulness or gross negligence Bjørn Lomborg's publication cannot be said to fall under this term. However, the publication is clearly seen to violate the norms of good scientific conduct.*"

Even though Bjørn Lomborg was in essence acquitted of scientific dishonesty in practice, the conclusion could be, and was, viewed as a serious criticism of his scientific credentials. The decision was controversial and divided the scientific community, with strong reactions from groups of Danish researchers both for and against the Committees. On the critical side, for example, there was an outcry among many social scientists, who felt that norms of good scientific conduct

originating in medical science were being superimposed on social science and the humanities. Thus many argued that it is common practice in large parts of social sciences and humanities to publish books without basing these on prior publications in international journals with peer review – which was one of the points of criticism underlying the decision.

Bjørn Lomborg himself complained to the Ministry. It was not possible to appeal the full decision made by the Committees, but it was possible to complain that the required legal procedures had not been complied with – which was what Lomborg did. Some of the main critical points made by Bjørn Lomborg were: a) Objective dishonesty cannot be treated as a separate entity to appear in a decision from the Committees. b) The Committees cannot just base their assessment of dishonesty on the decisions of others, as they here did by referring to the papers in *Scientific American*, but must assess the publication complained about on their own. c) The Committees cannot make a decision on violations of the norms of good scientific practice (as distinguished from scientific dishonesty). d) The book was not a scientific publication, as defined by the law, and it therefore did not fall under the remit of the Committees to assess it.

The Ministry accepted the complaint made by Lomborg on all four counts. As a consequence, it was made clear that the Committees should only consider the scientific activities of scientists, not their communication to a wider public; and that the assessment must be done by the Committees (possibly with the help of expert members of ad hoc groups). Furthermore the Committees' decisions should only conclude whether or not an accused scientist is guilty of scientific dishonesty in the full sense of the word; they may not draw conclusions about whether or not scientists are guilty of improper practice of research of a kind that does not amount to dishonesty.

Following the decision of the Ministry, the Committees decided not to re-consider the case. But after the Lomborg case the Committees changed their practice, and they no longer commented, in their conclusions, on possible violations of the norms of good scientific practice that do not strictly qualify as scientific dishonesty. The question whether good scientific practice has been followed in a case can still form part of the Committees' assessment in the case, but the *conclusion* is limited to whether or not scientific dishonesty has been committed.

This left a hole in the system, since the Committees could no longer deal directly with the grey zones between responsible conduct of research and scientific dishonesty. To rectify this situation it was decided by the responsible Minister that questionable research practices should be dealt with at university level. And it was written into the contracts between the Ministry and the universities that universities should ensure that good scientific practice is promoted and protected. As a consequence of this, in 2004 the University of Copenhagen established a Committee for Good Scientific Practice, also known as the Practice Committee. This committee differs from the Committees on Scientific Dishonesty in that it deals, not with cases of scientific dishonesty, but only with cases in the grey zone of questionable research practice. For more details on the Practice Committee, see Box 4.

Box 4: The University of Copenhagen Committee for Good Scientific Practice (the Practice Committee)

The Practice Committee was first established in 2004.

It consists of associate and full professors at the University of Copenhagen who are appointed by the academic councils, with two from both HEALTH and SCIENCE and one from each of the other faculties.

The Committee deals with written complaints about lack of good scientific practice (questionable research practices). It should not deal with complaints about scientific dishonesty, which should be referred to the national Committees on Scientific Dishonesty (see Box 1).

Furthermore, the Committee is responsible for helping to clarify the existing norms of good scientific practice and it may propose rules and guidance. Finally, the Committee takes steps to ensure public discussion of different aspects of good scientific practice, typically by means of a yearly meeting for all employees and students at the University.

For more information see: <http://praksisudvalget.ku.dk/english/>

So far the Practice Committee has examined about one to two cases a year. Most of the cases have involved disputes over authorship (see chapter 4). Some cases have been referred to the Committees on Scientific Dishonesty. However, there has been some uncertainty about how to draw the line between scientific dishonesty and questionable research practice owing to the rather open definition of scientific dishonesty found in the rules for the Committees on Scientific Dishonesty. According to these, scientific dishonesty consists of “falsification, fabrication, plagiarism or other serious violation of good scientific practice”. In light of recent developments, described in the following section, an effort is made to make this definition clearer.

4. Recent developments

Since 2010 there have been significant changes in the handling of RCR in Denmark and at the University of Copenhagen. These developments were to a large extent brought about by two spectacular cases, both involving the University of Copenhagen: The Penkowa case and the Klarlund case. The first of these cases led to general strengthening of the mechanisms supporting RCR, including mandatory courses for PhD students, as mentioned in chapter 1. It also led to the establishment of “Named Person” arrangements at the University of Copenhagen. Around the same time a Danish Code of Conduct for Research Integrity was issued. The latter seems to have influenced a recent effort to limit and clarify the remit of the Danish Committees on Scientific Dishonesty, and to draw a clear distinction between scientific dishonesty and questionable research practice.

Milena Penkowa received her degree as medical doctor at the University of Copenhagen in 1998 and then began a stellar career as researcher at the same university. She got her PhD degree in 2000, and less than a year later she handed in her doctoral thesis. However, the doctoral thesis was

rejected, and suspicions were raised about scientific dishonesty. After an internal review, part of which was conducted by the then Dean of the Medical Faculty and later Rector of the University of Copenhagen, Ralf Hemmingsen, it was concluded that there was no basis for raising a case with the Committees on Scientific Dishonesty.

Penkowa continued her career at the University of Copenhagen. She became associate professor in neuroanatomy in 2004, and then later the same year she submitted a revised version of her doctoral thesis on the basis of which she received her doctoral degree. In 2009 she received the prestigious EliteForsk Prize from the Ministry of Research, and later that year she was given the title of full professor.

However, in 2010 Penkowa was suspended following her conviction for economic fraud. Around the same time, very much as the result of work undertaken by an active journalist from the national newspaper *Weekendavisen*, it became clear that Penkowa had probably been involved in scientific dishonesty dating back to her doctoral thesis of 2001. A number of investigations were conducted at the University of Copenhagen, and a number of cases were raised at the Committees on Scientific Dishonesty. In some of these cases Penkowa has been convicted of scientific dishonesty; in others it was not possible to prove dishonesty. Investigations of fraud were still ongoing in 2015.

The conclusion of the Penkowa case was that scientific dishonesty and other forms of fraud had taken place, that this had been going on for more than a decade, and that despite a number of warnings and other signs of problems, things had been allowed to go on. So there was, both at the University of Copenhagen and nationally, a feeling that more had to be done to prevent scientific dishonesty and to deal with issues of questionable research practice.

Two of the many initiatives taken in the wake of the Penkowa affair have had a direct impact on the way breaches of RCR are handled and should therefore be mentioned here.

The first is that new arrangements in which so-called Named Persons are nominated were established, initially, in 2012, in the Faculty of Health at the University of Copenhagen, and then, in 2014, in the other faculties. The Named Person is a professor or associate professor at the relevant faculty to whom employees or students at the university can approach for advice and help, and for mediation in disputes. The Named Person is not part of the management, and she or he does not take initiatives on her or his own. Rather the main role of the Named Person is to assist people who are concerned about activities in their faculty which may involve questionable research practice or scientific dishonesty.

Whenever the Named Person is contacted she or he must make a record of the contact. If allegations are raised about a specific person, that person must be informed. When contacting the Named Person it may therefore be advisable not to mention any names initially. Rather, it may be a good idea to start by describing the problem in general terms. If it turns out that there is no reason to pursue the issue, the accused person will not know about it. If, on the other hand, a name is mentioned, the accused will be informed.

If accusations relate to cases that fall within the mandate of the Danish Committees on Scientific Dishonesty or the University of Copenhagen Practice Committee, the Named Person can advise the

complainant on how to present a case there. However, in reality many cases concern matters which can be dealt with through mediation, in which case the Named Person plays a central role.

Box 5: The Named Person

Since 2012 there has been a Named Person at the Faculty of Health, and since 2014 there have been Named Persons in all faculties at the University of Copenhagen.

The role of the Named Person is to serve as an advisor and point of contact for people who are concerned about possible scientific dishonesty or bad practice at their faculty.

The Named Person does not deal with anonymous allegations and must inform the accused. However, it is possible to get advice from the Named Person based on description of a case in general (anonymized) terms.

The Named Person can advise on how to pass on cases to relevant committees, but may also mediate in less serious cases.

The Named Person also promotes awareness of RCR at her or his faculty.

For more information about the Named Person at the Faculty of HEALTH see: <http://healthsciences.ku.dk/research/responsible-conduct-of-research/namedperson/>

For more information about the Named Person at the Faculty of SCIENCE see: <http://www.science.ku.dk/english/research/good-scientific-practice/named-persons/>

In public lectures the first Named Person at the Faculty of Health, Professor Jørn Hounsgaard, has described his activities over his first two years in office from October 2012 to October 2014. Some cases have been passed on to the relevant committee and some cases have been dealt with by giving advice in general terms. However, there have also been 21 cases where the Named Person has taken a more active role as mediator. Of these 21 cases 15 concerned authorship disputes, i.e. discussions about who should be included as co-authors, and in what order, on papers reporting collaborative research. In nine of the cases there was an element of personal conflict.

Another development taking place in the wake of the Penkowa case was that the Danish Ministry of Higher Education and Science and the organization Danish Universities decided in 2013 to develop a Danish Code of Conduct for Research Integrity (see also chapter 2). A working group led by a representative of the Ministry and with representatives from major Danish research institutions, including the universities, drafted the Code. After revisions based on a broad hearing process the Code was published in November 2014.

The main aim of the Code is “to support a common understanding and common culture of research integrity in Denmark”. The Code is directed both to individual researchers and to institutions. Institutions are expected not only to promote the principles and standards of RCR found in the Code, but also to develop policies that will integrate the principles and standards in their daily work.

The Code has received widespread support from the research community. All universities, including the University of Copenhagen, and major public and private foundations and research councils and research institutions, have signed up to the Code; and at the time of writing they are in the process of implementing its recommendations by defining policies on different aspects of RCR. At the University of Copenhagen the Practice Committee will assist the University management to develop such policies. The policies will cover most of the issues presented in the following chapters of this book.

Box 6: Danish Code of Conduct for Research Integrity

The Code provides principles of research integrity and recommendations on what can be considered proper standards for Responsible Conduct of Research. The Code is not a legally binding document in itself but aims to provide a framework for institutions and researchers to further promote research integrity.

The Code suggests standards covering the following six areas: 1. Research planning and conduct. 2. Data management. 3. Publication and communication. 4. Authorship. 5. Collaborative research. 6. Conflicts of interest.

Together these standards address the most common areas where questionable research practice may arise. In most cases the Code recommends that more specific policies must, where relevant, be defined by universities and other research institutions.

The Code also gives advice on teaching, training and supervision relating to Responsible Conduct of Research, and it describes the need for a system to handle scientific dishonesty and breaches of Responsible Conduct of Research. The Code can be downloaded from the following link:

<http://ufm.dk/publikationer/2014/filer-2014/the-danish-code-of-conduct-for-research-integrity.pdf>

Another important recent development influencing regulation of RCR in Denmark and at the University of Copenhagen is connected with the case against Professor Bente Klarlund Pedersen. She is a world known physiologist working at the University of Copenhagen and at one of the major University Hospitals in Copenhagen, Rigshospitalet. In 2011 a complaint of scientific dishonesty was filed against her by a colleague at the University of Copenhagen.

The case was taken on by the Danish Committees on Scientific Dishonesty, from which a final decision emerged nearly three years later. During those three years the case was covered extensively by the press, which meant that Klarlund had the suspicion of dishonesty hanging over her for years. When the final decision from the Committees was made public the suspicion was seemingly confirmed, as the Committee concluded that Klarlund was guilty of four cases of scientific dishonesty.

The decision gave rise to considerable controversy. It was criticized for not focusing on what could be viewed as typical kinds of Falsification, Fabrication or Plagiarism. The Committees' finding of scientific dishonesty mainly centered on an alleged lack of information about re-use of materials or results used in previous published studies and, in one case, failure to detect manipulation of images

in a paper of which Milena Penkowa was co-author and Klarlund was senior author. A number of prominent colleagues expressed the view, in the press, that most of the things Klarlund had done were in accordance with normal practice in the field, and that at most she was guilty of minor oversights and omissions rather than dishonesty.

Klarlund brought the Committees' decision before the Danish courts, and in February 2015 the High Court of Eastern Denmark ruled in favor of her. The decision of the court, which was not appealed, was that the decision by the Committees finding Klarlund scientifically dishonest was invalid.

In light of this situation and the latest developments in management of research integrity, shortly before the judgment of the high court was given, the Minister for Higher Education and Science set up a working group to review current regulation by the Committees on Scientific Dishonesty and suggest possible changes to the rules. It is expected that in the future the Committees on Scientific Dishonesty will work with a more narrow definition of dishonesty than the present, with a focus on fabrication, falsification and plagiarism. Thus other areas of unwanted conduct will be referred to the universities and their committees for good scientific practice.

5. Overview on how to handle issues regarding RCR

When a researcher at the University of Copenhagen has questions about research, and is in doubt as to how to behave, or is in doubt about the behavior of colleagues or students there, are a number of things she or he should do:

- 1) A good starting point would be to look at the Danish Code of Conduct (see Box 6 above), to look through the present book, and to consult the web-page of the Practice Committee, for guidance.
- 2) If doubts remain, a logical next step would be to contact the Named Person at the relevant faculty. The Named Person can give advice; and in cases of disagreement she or he can try to mediate. It is also possible to seek advice from colleagues, the head of section or head of department.
- 3) If the case concerns questionable research practice, and if the Named Person is not able to mediate, the next step may be to file a written complaint to the University of Copenhagen Practice Committee.
- 4) Finally, if the case is about scientific dishonesty a complaint should be filed with the Danish Committees on Scientific Dishonesty. For younger researchers, it may be a good idea to ask a senior colleague, the head of section or the head of department, to file the complaint.

So the key to dealing properly with issues regarding RCR is to seek information and help.

6. Test yourself questions

- What requirements must be satisfied if the actions of a researcher are to amount to a case of scientific dishonesty?
- In a collaborative project you become aware that a colleague reporting results has omitted a number of data points which, if they were retained, would affect the statistical validity of the study. How should you handle this situation?

- What, according to Danish Code of Conduct, are your main responsibilities as a researcher when it comes to the planning of research?
- Can you approach the Named Person with allegations about a colleague and remain anonymous?
- If a case similar to the Soman case (see Ch. 2) were to occur today in Denmark, how would the Danish systems for handling violations of RCR make a difference?

References

The account of the Lomborg case in Section 3 is based on material provided to the author by the Ministry for Higher Education and Science. The description of the workings of the University of Copenhagen Committee for Good Scientific Practice is based on material to found on the Committee's Danish website. See: <http://praksisudvalget.ku.dk/>

The description of the Penkowa case in Section 4 is mainly based on material found at the University of Copenhagen website. See: <http://nyheder.ku.dk/penkowa/>

A brief summary of the Klarlund case can be found at the following webpage of the High Court of Eastern Denmark:
http://www.domstol.dk/oestrelandsret/nyheder/domsresumeer/Pages/Pressemed_18_02_15.aspx

An account of the Klarlund case in English can be consulted on the *Nature* webpage. See: <http://www.nature.com/news/danish-court-quashes-ruling-against-physiologist-1.16960>

4 Authorship and other publication issues

*Mickey Gjerris & Karsten Klint Jensen*⁴

Summary

In this chapter we shall give a detailed description of the Vancouver Recommendation's requirements for authorship. We also mention some alternative guidelines and some further issues concerning authorship. Next, we discuss various forms of undeserved authorship. There is a discussion of the consequences of forms of undeserved authorship, and of how widespread they are, followed by a discussion of a number of other publication issues. The chapter concludes with some recommendations to PhD students on how to handle publications and minimize problems and conflicts.

1. Introduction

In most scientific fields peer-reviewed publications are the most accepted means of communicating research results. It is fundamental to science that new findings are shared with the scientific community both to enable critical assessment and, if the findings stand up to scrutiny, so that others can learn from them and build on them in their own research. At the same time, publications have become one of the primary measures by which scientists are ranked – for example, when they apply for positions or for research funding. The phrase “publish or perish” reflects the fact that scientists are always striving competitively to have the most, and the most influential, publications. Hence, a currently widespread way to compare scientists uses bibliometric measures based on the individual researcher's number of publications and citations.

Box 1

Imagine that you are about to finish the first article for your PhD thesis. Together with your main supervisor and one of your co-supervisors, who works at another university, you have decided on the subject area and methodology. A postdoc at the other university has performed some measurements for you. You have gathered the data and written the first draft of the paper and have discussed possible interpretations of the data with your supervisors. Both have commented in detail on the first draft. Having revised the manuscript, you have circulated it again, and then received an e-mail from your co-supervisor who declares it ready for submission – but who also requests that you add the postdoc as a co-author as well. You ask your supervisor what to do, and he advises you to do as requested as the co-supervisor is coordinator on a research application that your research group needs to be a central part of if they are to get a share of the grant. Declining the request will just antagonize the co-supervisor, whom your main supervisor knows very well.

⁴ We should like to thank Hanne Andersen for her editing of a previous version of the text. We should also like to thank Peter Sandøe, Louise Whiteley and Mathias Willumsen for valuable comments.

Hopefully, you have not been in a situation like the one described in Box 1. But crediting authorship to someone who does not qualify as an author is unfortunately not a rare practice. In this chapter, we shall present the most important international and Danish guidelines on authorship issues and discuss in detail what they imply. We also discuss various other publication issues of importance for a PhD student. In the final section, we discuss what one can do to avoid engaging in such questionable practices.

2. Requirements for authorship

2.1 The Vancouver Recommendations

There are no globally accepted rules on academic authorship; and different disciplines and different cultures may have different traditions. However, in 1978 an influential group of editors of medical journals known as the International Committee of Journal Medical Editors (ICJME: see www.icjme.org) met in Vancouver and formulated a set of recommendations now widely known as the ‘[Vancouver Recommendations](#)’. Originally, they were called *Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication*. However, they have since been updated several times, most recently in 2013, and now they are called *Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals*.

Although the Vancouver Recommendations have grown out of the medical sciences, the principles they express are widely adopted today across the natural sciences and, to a lesser extent, beyond. In Denmark, they have become highly influential because various guidelines refer to them. Thus the Danish Committees on Scientific Dishonesty (DCSD) uses them as the basis for their “Guidelines on publication matters” in chapter 5 of their 2009 *Guidelines for Good Scientific Practice*.⁵ At the University of Copenhagen, the Practice Committee also refers to the Vancouver Recommendations as an expression of their standards on authorship. Also the more recent *Danish Code of Conduct for Research Integrity* (2014) confirms the principles underlying the Vancouver Recommendations.

Box 2: The Vancouver Recommendations (2013, p. 2)

*The ICMJE recommends that authorship be based on the following 4 criteria:*⁶

- 1. Substantial contributions to the conception or design of the work; OR the acquisition, analysis, or interpretation of data for the work; AND*
- 2. Drafting the work or revising it critically for important intellectual content; AND*

⁵ DCSD decided in 2015 that these guidelines will no longer be updated because the publication of the new Danish Code of Conduct for Research Integrity (2014) makes this unnecessary. The guidelines can still be accessed as a historical document, however, and indeed we have done this where relevant in this chapter.

⁶ We have used capital-lettering to emphasize the logical connectives.

3. Final approval of the version to be published; AND

4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

In addition to being accountable for the parts of the work he or she has done, an author should be able to identify which co-authors are responsible for specific other parts of the work. In addition, authors should have confidence in the integrity of the contributions of their coauthors.

All those designated as authors should meet all four criteria for authorship, and all who meet the four criteria should be identified as authors. Those who do not meet all four criteria should be acknowledged [...].

These authorship criteria are intended to reserve the status of authorship for those who deserve credit and can take responsibility for the work. The criteria are not intended for use as a means to disqualify colleagues from authorship who otherwise meet authorship criteria by denying them the opportunity to meet criterion #s 2 or 3. Therefore, all individuals who meet the first criterion should have the opportunity to participate in the review, drafting, and final approval of the manuscript.

We shall now explain the four Vancouver requirements for authorship in more detail.

1) Contributions to the research process

The first requirement is to have provided a substantial contribution to the research process, from the conception of the idea to the analysis of the data. However, the term ‘substantial’ is vague and open to interpretation. As examples of contributions that are *not* sufficient to merit authorship, the ICMJE list acquisition of funding, general supervision of a research group, and general administrative support.

The publication *Guidelines for Good Scientific Practice* issued by DCSD (2009) specifies that the key to understanding what is meant by a ‘substantial contribution’ is the term *creative*: “It is internationally acceptable that right to authorship is acquired by creative efforts and only thereby”. On this interpretation, authorship is not merited if one has not been part of the creative part of the scientific process. It is, for example, insufficient to have performed routine laboratory work, even if it has been very labor intensive. However, if the laboratory work involved development of new methods, adjustments in the design of experiments, or the like, it may count as creative.

2) Contributions to the written text

The second requirement states that all authors must have participated in producing the written text. This may be through participation in preparing a draft manuscript or through critical revisions of importance in the final text. The central requirement in all cases is that the contribution has importance for the intellectual content. As a minimum this will require a careful reading of the manuscript where comments and suggestions for changes are added. As examples of contributions

that are *not* sufficient to merit authorship, the ICMJE group lists: writing assistance, technical editing, language editing, and proofreading.

3) Approval of the final manuscript

All co-authors need to read and approve of the final version. DCSD *Guidelines* state (p. 32) that:

an author shall be able to indicate in detail his or her own contribution and must have participated to such degree in the entirety of the work that the relevant party is able to indicate the full contents of the manuscript and be able to discuss fundamental aspects of the remaining contributions.

The *Guidelines* then point in the direction of the fourth requirement:

Furthermore, all authors of an article – within the limits of what is possible and fair – are co-responsible for it being based on honest research so as for the risk of fraud to be minimised. If irregularities or dishonesty are proven in the research, it will be difficult for the co-authors of such work to disclaim co-responsibility.

4) Agreement to be Accountable

The fourth requirement was added in 2013. The ICMJE explains it thus (http://www.icmje.org/news-and-editorials/new_rec_aug2013.html):

Authorship involves not only credit for the work but also accountability. The addition of a fourth criterion was motivated by situations in which individual authors have responded to inquiries regarding scientific misconduct involving some aspect of the study or paper by denying responsibility ("I didn't participate in that part of the study or in writing that part of the paper; ask someone else"). Each author of a paper needs to understand the full scope of the work, know which co-authors are responsible for specific contributions, and have confidence in co-authors' ability and integrity. When questions arise regarding any aspect of a study or paper, the onus is on all authors to investigate and ensure resolution of the issue. By accepting authorship of a paper, an author accepts that any problem related to that paper is, by definition, his or her problem. Given the specialized and myriad tasks frequently involved in research, most authors cannot participate directly in every aspect of the work. Still, ICMJE holds that each author remains accountable for the work as a whole by knowing who did what, by refraining from collaborations with co-authors whose integrity or quality of work raises concerns, and by helping to resolve questions or concerns if they arise.

The new thing here appears to be the duty to help in resolving issues of potential misconduct, if they arise. It is not possible for an author to deny responsibility for this by claiming that he or she is not responsible for parts of the paper he or she did not participate in. It is also an implication that authors need to assess the integrity and trustworthiness of all co-authors. The further implication of this is that if a person has engaged in questionable practices, and has thereby raised concerns about

his or her own integrity, he or she may end up in a position where others refrain from collaborating with him or her on publications.

The *Danish Code of Conduct for Research Integrity* (2014) contains the clause that “[i]n addition to being accountable for the parts of the work he or she has done, an author should be able to identify which co-authors are responsible for other specific parts of the work.” However, it is later clarified that responsibilities may be variable among co-authors:

All authors are responsible for the content of the publication. However, the responsibility of each author should be assessed subject to their individual role in the research by considering their area of expertise, their experience and seniority, a possible supervisory role, and other relevant factors. Thus, in some cases an author may have a wider responsibility than others for ensuring the integrity of the publication or specific parts of the publication.

2.2 Deviating Practices

In some fields, particularly those involving very large teams of researchers, the Vancouver Recommendations are not considered adequate. Alternative guidelines, not least for these areas, have been proposed by the journal *Neurology* (<http://www.neurology.org/site/misc/auth2.xhtml#AUTHORSHIPREQUIREMENTS>) and an editorial in the *British Medical Journal* by Baskin and Gross (2011), and these also seem to be echoed in *The European Code of Conduct for Research Integrity* (see p. 14-15).

Box 3: *Neurology*’s authorship policy

Criteria for qualification (intellectual contributions):

Design or conceptualisation of the study

Or analysis or interpretation of the data

Or drafting or revising the manuscript

All authors acknowledge all versions.

Those who do not qualify as authors are listed as co-investigators or contributors.

Any paid medical writer who wrote the first draft or responded to the reviewers’ comments must be included in the author byline.

All authors must complete and sign authorship forms with roles and contributions, disclosure forms listing all sources of potential bias, and copyright transfer agreements; author contributions and disclosures are published in the journal.

These requirements are less demanding than the Vancouver Recommendations. The crucial difference is that a co-author does not need to contribute to the written text. In a large team, it is accepted that one or just a few authors do the writing. Moreover, taking part in the writing is considered a sufficient intellectual contribution, in line with the Vancouver Recommendations. However, the requirement of full transparency about the role of each author is more demanding than the corresponding accountability rules in the Vancouver Recommendations.

Since the *Danish Code of Conduct for Research Integrity* (2014) refers to the Vancouver Recommendations as its standard, one might think it is a violation of the *Code* to follow *Neurology*'s authorship policy. However, the foreword of the *Code* says: "The Recommendations of the Code should always be understood in accordance with established practices predominant within the individual fields of research". We see this as an indication that substantiated reasons based on practices within a certain research field may justify deviations from the general policy.

2.3 Order of authors

When submitting a manuscript for publication, it is necessary to decide, not only who is to be listed as authors, but also the order in which the authors should appear in the byline. In most fields, authors are ordered according to the importance of their contributions, and special academic merit is therefore attached to particular positions. The author listed first on the byline (the 'first author') is selected for having contributed the most significant effort and for drafting the first manuscript. The last position on the byline (often referred to as the 'senior author') is reserved for the (typically senior) principal investigator who had overall responsibility for the project. The remaining authors are ordered according to the estimated significance of their contributions. Both first authorship and last authorship can be allocated to two people if they have played similar roles; this should then be noted in the paper and can later be written as an explanatory footnote in the resume.

However, again, these principles are not followed universally. In some fields with large teams of researchers authors are simply ordered alphabetically and no special academic merit attaches to the first or last position in the list. See Marusic et al. (2011) for a review of the meaning and practices of authorship across different disciplines.

Typically, either the first author or the last author will be responsible for internal communication among all authors. Likewise, one of them will serve as the corresponding author who makes sure that the journal's guidelines are properly followed and communicates with the journal about responses to review reports and revisions of the manuscript. In some fields the senior author is normally expected to assume a special responsibility for the validity of the work, and he or she should therefore take extra care in reviewing the contributions of the other authors.

The ordering of authors in the byline, especially where the positions of first and last author are concerned, can of course create conflicts, especially if clear agreements have not been made from the outset. It is therefore advisable to prepare a draft statement when initiating a collaboration that specifically addresses this issue (see Box 4).

2.4 Authorship declarations

DCSD recommends that “[p]rior to submission of the manuscript, a common authorship declaration ought to be prepared, which precisely indicates the nature and volume of each author’s contribution”. Today, an increasing number of journals require all co-authors to submit a signed statement that they have read and approved the final version of the manuscript before it will be considered for publication. Some journals also require contribution statements that specify what each author has contributed, and some even ask to know what percentage of the work was done by each author.

For PhD students enrolled at a Danish university, the Ministerial Order #1039 of August 27 2013 on The PhD Degree Programme at the Universities and Certain Higher Artistic Educational Institutions (sometimes referred to simply as the PhD Order) specifies that where a dissertation includes articles written in collaboration with others, a written declaration (co-author statement) describing the PhD student’s contributions to the work must be submitted. Standard forms for these declarations can be found on Danish university websites. The co-author statements must be submitted with the dissertation, and if they are not completed correctly, or do not bear the signatures of all co-authors, the university may not accept the dissertation. These submissions should not be confused with the co-author statements that journals require researchers to fill out when they are submitting papers for publication. With the latter, specific requirements may differ from one journal to another.

2.5 Acknowledgements

If other researchers have contributed to the article in ways that do not merit co-authorship, they should be thanked in the acknowledgement section of the article. Admittedly, there is not much formal academic recognition in such an acknowledgement, but it nevertheless serves important functions. First of all, it is a question of expressing gratitude where thanks are due. That will also increase the likelihood that people will be help again on another occasion. Furthermore, for some institutions it may be a parameter of success to be able to document that one has assisted the research of others. Finally, acknowledgements also help to make transparent who actually contributed to the paper.

However, although, unlike authorship, being acknowledged does not imply responsibility for the content of the publication, the acknowledgement may still be seen as an endorsement of the paper; and someone who qualifies for acknowledgement may not want to be seen as endorsing the work. The ICMJE group therefore recommends that “[b]ecause acknowledgment may imply endorsement by acknowledged individuals of a study’s data and conclusions, editors are advised to require that the corresponding author obtain written permission to be acknowledged from all acknowledged individuals” (Vancouver Recommendations, p. 3).

3. Undeserved authorship

Sometimes the author byline will list people whose contribution does not merit authorship (undeserved authorship). Below we shall briefly describe the main categories of this kind of questionable research practice. The *Danish Code of Conduct for Research Integrity* states (4.1 viii): “Guest authorship (i.e. listing authors who do not qualify as such) or ghost authorship (i.e. omitting individuals who should have been listed as authors) should not take place. “

3.1 Gift authorship

Gift authorship (also sometimes known as *honorary authorship*, or, when asymmetric power relations are involved, *coerced authorship*) is authorship that has been granted to, and accepted by, a person who does not fulfil the requirements for authorship. The reasons for granting authorship to somebody whose contribution does not merit authorship can be various. At some institutions, or in some fields, the head or director of a unit (e.g. a department, laboratory or research group) has traditionally been added routinely as co-author of all articles published by the unit. However, if he or she does not satisfy the requirements of authorship described above, this is gift authorship and therefore undeserved. The *Danish Code of Conduct for Research Integrity* states (4.1 vi): “Participation solely in the acquisition of funding, in the collection of data, or in general supervision of the research group does not justify authorship.”

DCSD explicitly mentions “the head of institute’s provision of framework conditions, specialist departments’ services of routine data or mere help in collection of data” as examples of non-creative contributions which do not in themselves merit authorship status. DCSD also says: “The guidelines [i.e. on publication matters] may give rise to problems for supervisors accustomed to gift-authorships. However, the right to authorship must follow the usual rules, also in this relation, and accordingly, only supervisor(s), who meet the above three requirements⁷ [for authorship] should be co-author(s).”

Sometimes authorship is granted to a person who does not satisfy the requirements for authorship because one of the other authors owes him, or her, a favor; or authorship may be granted in order to strengthen a relationship through the exchange of a gift. Sometimes this exchange can be coerced – for example, when a lab whose assistance is needed for some routine services request co-authorship in return even though this is not merited by their contribution.

Gift authorships are also sometimes swapped among researchers as a way to artificially inflate the number of publications on their publication lists. But note that, according to the Vancouver Recommendations, in receiving a gift authorship one becomes accountable for work that one has not been involved in – and may not even know about.

⁷ The 2009 DCSD guidelines mention only three requirements corresponding to the first three Vancouver Recommendations.

3.2 Planted authorship

A planted authorship is a gift authorship that the recipient was not informed about. In such cases, the intention is normally not to benefit the recipient, but to strengthen the impression that the article has a pedigree background (and perhaps also to facilitate passage through the peer-review process) by including a highly ranked or well-known scientist as co-author.

This is problematic for several reasons. First of all, it obviously gives a false impression of the real authorship, and thereby of who is responsible for the content of the article. And, unknown to him or her, the recipient of the gift may end up being held responsible for research which turns out to be of low quality or perhaps even an example of misconduct.

However, to the extent that journals require signed co-authorship statements from all authors, planted authorships are likely to become extinct.

3.3 Ghost authorship

Ghost authorship is the opposite of gift authorship. Despite deserving authorship, the ghost is hidden by being omitted from the byline. This may, for example, be done with the aim of hiding a possible conflict of interests. A typical case is an author from a private company, who fears that a publication will lose in credibility if he appears as author thereby signaling that the research was conducted in collaboration with industry. However, the Vancouver Recommendations state clearly that authorship is not only a right, but also a duty. If a person satisfies the criteria of authorship, she or he should also figure as an author.

More and more PhD projects are undertaken in close collaboration with industrial partners who have direct commercial interests in the results. In these cases, transparency about authorship and funding is very important. For more on conflicts of interest, see chapter 7.

A number of cases have been uncovered in which medical companies get their results published with the authorship of seemingly independent researchers who downplay the risks, or overstate the benefits, of a drug. Wislar et al. (2011) found that more than 20% of the articles in six high-impact medical journals had either gift authors, or ghost authors, or both. The practice whereby, for example, an author is paid to write about the side-effects of drugs when he or she has not participated in the research himself, and at the same time it is undeclared that the research was performed under the influence of commercial interests, is of course highly questionable.

4. Consequences of undeserved authorships

4.1 How widespread is undeserved authorship?

According to the International Association of Scientific, Technical and Medical Publishers (STM) in 2012 there were more than 28,000 journals in the fields of medicine, science, and technology, and together these journals publish more than 1.8 million peer-reviewed articles a year.

A study of research misconduct and questionable research practices in general (Martinson et al., 2005) based on anonymous self-reporting by several thousand early- and mid-career researchers in US showed that 12.3% of mid-career and 7.4% of early-career researchers had inappropriately assigned authorship credits within the last 3 years. In another study, this time of German universities, Böhmer et al. (2011) found that by far the most common questionable research practices related to authorship. More than half of the respondents reported that they had experienced such issues.

Interestingly, Yank and Rennie (1999) examined contribution statements published with articles in the medical journal *The Lancet*. Analyzing these descriptions of the contributions of each individual author, they found that 44% of the authors did not satisfy the requirements of the Vancouver Recommendations.

Focusing specifically on authorship, Wislar et al. (2011), as mentioned above, surveyed six general medical journals with high impact factors. Corresponding authors of a randomly selected sample of articles were asked about the contributions and function of all authors. Based on the replies, it was investigated whether all of the authors of each article had complied with the Vancouver Recommendations on authorship. The results showed improper authorship affected 21% of the articles. Comparing the results to those of a similar study from 1998 by Flanagan et al. which had found improper authorship in 29% of articles, Wislar et al. concluded that increased efforts by both journals and academic institutions are important for maintaining integrity in scientific publication.

Thus, even though the Vancouver Recommendations are widely accepted, authorship issues remain widespread. This is confirmed by the fact that most of the cases handled by the University of Copenhagen Practice Committee and by Named Persons in the Faculty of Health and Medical Sciences and the Faculty of Science are concerned with authorship issues.

4.2 What is the problem?

There are several reasons why undeserved authorship credits and ghost authorships are considered a questionable research practice, or, in serious cases, research misconduct. These reasons relate to the implications for colleagues, science as an institution, and society.

For one thing, boosting your publication list with false authorship credits gives you an unfair advantage in the competition with others. This is simply cheating – or, as it has also been called, “academic doping”.

Secondly, crediting undeserved authorships and not crediting qualified authorships may also harm science as an institution. For one thing, it renders it opaque who is responsible for what in the scientific literature. But knowing who is responsible, and for what, is important, when questions or criticisms are put concerning methods, data or the interpretation of results.

Further, a culture of such undeserved advantage in the competition damages the reputation of science, and in the long run it may undermine the society’s trust in the results of science, as those who produce them come to be seen as untrustworthy.

Finally, from the perspective of society, a practice of crediting undeserved authorships, and not crediting qualified authorships, implies that resources may not be being allocated optimally. Many countries invest a great deal in scientific research in the hope either that this may help us to solve the grand challenges we face (from climate change, to cancer, to famine), or simply to promote economic competitive advantage. Since authorship is the most important parameter for obtaining academic positions and funding, misrepresentation of one's qualifications means that the resources spent on science will not necessarily end up with the most qualified scientists, but rather with those who (via false citations and the like) are best at appearing most qualified.

Given these consequences of underserved authorship, it is not surprising that increasing attention is being given to authorship – both with respect to how it can be made more transparent through better implementation of, for example, the Vancouver Recommendations, and with respect to the question of how to evaluate the qualifications of individual scientists more accurately.

5. Other publication issues

5.1 Prepublication

Many journals, especially in biomedicine, will not publish results based on data that has already been presented publicly, for example, in conference proceedings; other journals may do so. It is therefore necessary, before engaging in prepublication, to check whether this effort to publish will preclude later publication in relevant journals. It is also necessary to be careful about when and where to present data and results at conferences. A PhD student should check with his or her supervisor before presenting work in any public form in order to avoid problems with later publication.

Secondary publications are generally considered acceptable ways of, for example, reaching different audiences (e.g. a national audience, or researchers from different fields), but they normally require the agreement of both journals, and they must be made fully transparent by inserting a cross-reference to the original version of the article. As a general principle, the *Danish Code of Conduct for Research Integrity* states (3.1 ii): “Publishing the same results in more than one publication should only occur under particular, clearly explained and fully disclosed circumstances.”

The ICMJE lists the following conditions:

1. *The authors have received approval from the editors of both journals (the editor concerned with secondary publication must have access to the primary version).*
2. *The priority of the primary publication is respected by a publication interval negotiated by both editors with the authors.*
3. *The paper for secondary publication is intended for a different group of readers; an abbreviated version could be sufficient.*
4. *The secondary version faithfully reflects the data and interpretations of the primary version.*

5. *The secondary version informs readers, peers, and documenting agencies that the paper has been published in whole or in part elsewhere—for example, with a note that might read, “This article is based on a study first reported in the [journal title, with full reference]”—and the secondary version cites the primary reference.*
6. *The title of the secondary publication should indicate that it is a secondary publication (complete or abridged republication or translation) of a primary publication.*

Undisclosed duplicate publication is in general discouraged. It is likely to be treated as a questionable practice, and even as research misconduct (self-plagiarism). It may distort the scientific record by giving undue weight to the results, which are in this way being reported several times. For example, if the same data from a study of the side-effects of a medical treatment are published several times, review studies will be skewed. Ultimately, this may putting patients at risk. See, for example, Tramer (1997) for a case study.

5.2 Inappropriate recycling of material

When the sections of the same text appear in several of an author’s publications, this is referred to as text recycling, or self-plagiarism. Attitudes to text recycling have developed over time and vary from field to field. Unfortunately, there is no well-defined boundary indicating when a textual overlap between two articles is so substantial as to be classified as a case of recycling. See, for example, Bretag and Mahmud (2009) as well as Bruton (2014) for more detailed discussions of the definition of text-recycling.

The Danish Code has the following policy (3.1 iii): “Recycling or re-use of primary materials, data, interpretations or results should be clearly disclosed.” In some fields, a certain degree of recycling is difficult to avoid, especially in sections such as methods and materials. In these cases, recycling may even be encouraged to ensure a precise and easily recognizable description of, for example, a technique. However, such recycling should be made transparent in a cross-reference to the earlier article in which the material, method or technique was first described. Similarly, previous work may be recycled to serve in the introduction to a new article, but again such recycling should be made transparent in cross-references.

5.3 Manuscripts Based on the Same Database

The ICMJE states, about manuscripts based on the same database, that:

Editors might consider publishing more than one manuscript that overlap in this way because different analytical approaches may be complementary and equally valid, but manuscripts based upon the same dataset should add substantially to each other to warrant consideration for publication as separate papers, with appropriate citation of previous publications from the same dataset to allow for transparency.

Lack of transparency is problematic because readers can be misled to believe that the reported results derive from different studies or different samples, and in this way the scientific record may be distorted.

Data fragmentation occurs when available data is partitioned so as to produce multiple articles, where they could instead have been published together. Sometimes, this is done deliberately with the purpose of creating more publications (so-called ‘salami publication’). This may be considered a dubious practice, because it gives the author an unfair advantage in competition, and because it wastes time and resources. However, it is difficult to pin down exactly when the practice is dubious, because word limits and other restrictions imposed by journals may actually prohibit publication of the material in one paper. In all cases, transparency should be the guiding principle.

5.4 Plagiarism versus proper attribution

In science, researchers almost always draw on previous work by others. Unless this work has become so established that it is considered common knowledge, the use of another researcher’s work – whether data, results or other text – should always be clearly attributed, and references to the original work should be sufficiently detailed to enable readers to find the relevant passage.

Verbatim text taken from the work of others must always be marked as quotation, and paraphrases as well as translations must always be accompanied by a reference to the original. Failing to do this is plagiarism, which may be considered a form of scientific misconduct (see also chapter 2).

Authors writing in a language other than their mother tongue may find it tempting to use phrases they have read in the publications of native speakers: see Yilmaz (2007), for such a case. However, while this may be a good strategy for language learning in everyday conversation, it is a questionable practice in academic publications, where it counts as plagiarism.

Software developed to detect similarities between multiple texts, including software that compares a submitted text to all publications available in a particular corpus (e.g. arXiv, MedLine abstracts, etc.), has revealed many cases of plagiarism in the literature (see, for example, VroniPlag at <http://de.vroniplag.wikia.com/wiki/Home> or Déjà vu at <http://dejavu.vbi.vt.edu/dejavu/>). In addition, more and more journals are now running new submissions through plagiarism detection software like iThenticate or Turnitin. Currently, for a trial period, all PhD dissertations at the Faculty of Health and Medical Sciences, University of Copenhagen, are checked by iThenticate before being accepted for further assessment.

5.5 Publication of negative results

Negative results can be difficult to get published. To attract readers, journals generally seek to publish new and exciting positive results, and grant-giving agencies and foundations want to see that their money is well spent. This leads to an environment where positive results are much easier to publish than negative ones, even though negative results can be of high scientific value. Just imagine the time that you could save yourself if you did not have to go through a laborious research

process to find out that your hypothesis is wrong, but could rather simply read that others had already provided the relevant disproof. In recognition of this, journals specifically aimed at publishing negative results have appeared, such as *The Journal of Negative Results in Biomedicine*. Such journals are very valuable to the scientific community, but usually they lack a high impact factor.

Failure to publish negative results may lead to so-called publication bias. As it is easier to publish studies with positive than negative results, there is a risk that reviews of the literature will show a false picture of the world, with the positive results being given disproportionate weight. However, as is stressed in the *Danish Code of Conduct for Research Integrity*, researchers have a responsibility to be transparent about their results, including omissions.

5.6 Non-academic publications

The Vancouver Recommendations apply to academic publications only. These include, not only peer-reviewed articles in journals, but also chapters in collections and monographs published by academic publishers, as well as non-peer reviewed publications that are nevertheless research publications. However, most scientists also publish other kinds of writing, such as popular articles for the general public. Often such non-academic publications are based on previously published academic papers.

There are no formal academic guidelines for non-academic publications, but the rules and guidelines on publishing as such apply to them; for example, copyright regulations apply. Although the Vancouver Recommendations ignore non-academic publications, it may still be wise to consult others and discuss how their contributions should be recognized when you are considering non-academic publication.

6. How to manage your publications as a PhD student

As a PhD student you will need to manage your publication issues yourself, especially authorship issues, since you cannot expect anyone else to take responsibility. However, this may involve difficult situations.

On the one hand, you are responsible (in part) for decisions about who is added as a co-author to the byline of your articles. On the other, you might work in an environment where you come under pressure to accept a questionable practice; and whistle-blowing may give rise to conflict with your collaborators.

To minimize the risk of unpleasant conflict we suggest that you follow the advice given in the “Guide to minimizing authorship issues” (see Box 4) below.

Box 4: Guide to minimizing authorship issues

Arrange a meeting with your supervisor on publications for your PhD. One of the items on the agenda should be authorship issues.

If it is relevant, make it clear that you intend to follow the *Danish Code of Conduct for research Integrity* and DCSD's *Guidelines for good scientific practice*, chapter 5, and/or The Vancouver Recommendations; and discuss at the meeting how you will manage your publications in the light of these documents.

When you are initiating collaboration with others on an article make a draft statement that specifies who is to be included as a co-author and how the workload will be distributed, and seek to ensure that the involved parties accept and sign up to it. Encourage people seeking co-authorship to make suggestions as to how they can contribute to qualify as co-authors – this applies equally to heads of department and fellow PhD students. Keep a record of agreements to consult in cases of doubt. Of course, initial agreements may need to be revised as the work progresses, but changes in agreements should be recorded explicitly. Make sure to have the co-authorship statements that are required for submitting your dissertation ready and signed by all relevant parties before submitting a manuscript.

If you ever come under pressure – for example, from a lab – to grant co-authorships in return for access to technical equipment or routine services, you should ask your supervisor to assist you in the negotiations. In the unfortunate circumstance that your supervisor turns out not to be helpful, you may contact the Named Person designated for your faculty and seek advice.

In the last resort, you will have to decide: Do you want to make a complaint because you cannot agree to engage in a questionable practice? Or is the prospect of causing a conflict by making a complaint so serious that you would prefer to accept a questionable practice?

7. Test yourself questions

- What are the Vancouver Recommendations' requirements on authorship?
- What should you do if you observe someone being credited with unwarranted authorship?
- What should you do if someone requires to be a co-author of your paper?
- Who can you approach for help with conflicts over authorship?
- Should a researcher who participates in data acquisition and analysis, but who lacks the skills in English to engage in the writing process, be credited as a co-author?

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5 Data handling and data management

Introduction

Responsible practice in Data Handling and Management is an area undergoing rapid development. New guidelines for the University of Copenhagen are expected in early 2016. Until then, we refer the reader to the national guidelines on data management.

Section 5.1 contains relevant excerpts from the Danish Code of Conduct for Research Integrity (2014), supplemented by more detailed guidelines from the Danish Committees on Scientific Dishonesty (2009) in Section 5.2.

It is important to note that since the advent of the Danish Code of Conduct for Research Integrity in 2014, the Danish Committees on Scientific Dishonesty guidelines are no longer updated. The reader should therefore be aware that the guidelines in Section 5.2 may be outdated by recent developments in certain areas. If in doubt, consult with your supervisor, your local data management team, or your faculty's Named Person.

5.1 Excerpts from the Danish Code of Conduct for Research Integrity

The full document is available at:

<http://ufm.dk/publikationer/2014/filer-2014/the-danish-code-of-conduct-for-research-integrity.pdf>

2. Data management

Responsible conduct of research includes proper management of primary materials and data. The key purpose of data management is to guarantee credible and transparent research.

DEFINITIONS

Primary material is any material (e.g. biological material, notes, interviews, texts and literature, digital raw data, recordings, etc.) that forms the basis of the research.

Data are detailed records of the primary materials that comprise the basis for the analysis that generates the results.

2.1. Responsibilities

- i. Primary materials and data should be retained, stored and managed in a clear and accurate form that allows the result to be assessed, the procedures to be retraced and – when relevant and applicable – the research to be reproduced. The extent to which primary materials and data are retained and the recommended retaining period should always be determined by the current practices applicable to the specific field of research. However, data should in general be kept for a period of at least five years from the date of publication.
- ii. The data records should enable identification of persons having conducted the research and persons or institutions with responsibility for the primary materials, data, and research results. The data records should contain a precise and traceable reference to the source. Any changes to the primary materials or data stored should be clearly accounted for in a way that allows clear identification of the changes made.

2.2. Division of responsibilities

- i. **Researchers** are responsible for storing their primary materials and data.
- ii. **Researchers** are – unless otherwise regulated – responsible for deciding the extent to and duration for which primary material is to be retained. When deciding this, **researchers** should consider the value of the primary materials for assessing the results of the research and the physical and technical possibility of storage at the institution.

- iii. **Institutions** should maintain a policy on the retention of primary materials and data that includes information on:
 - a. Storage of primary materials and data
 - b. Secure and safe disposal of primary materials and data after the retention period
 - c. Responsibility for and access to primary materials and data
 - d. Data retention, accessibility and ownership when researchers leave the institution
- iv. **Institutions** are responsible for providing secure data storage facilities that are consistent with confidentiality requirements and applicable regulations and guidelines, e.g. on the processing of personal data.
- v. **Institutions** should allow access to the stored primary materials and data, except when this is in conflict with contractual legal obligations or current regulations on for example ethical, confidentiality or privacy matters or intellectual property rights.

5.2 Excerpts from the historical guidelines from the Danish Committees on Scientific Dishonesty: Guidelines for Good Scientific Practice (January 2009)

The full document is available at:

<http://ufm.dk/en/publications/2009/files-2009/historical-guidelines-for-good-scientific-practice.pdf>

Chapter 4

Guidelines relating to rights and duties concerning storage and use of research data

As a part of promoting good scientific practice and preventing conflicts between scientists or research institutions internally and among scientists or research institutions and other parties, it is recommended that the below guidelines on rights and duties of filing and on right and duty of use in connection with research data be observed.

The purpose of scientific work (research) is to provide reliable new knowledge, and is characterised by descriptive, hypothesis generating research and actual hypothesis testing, based on systematic collection and analysis of data, including qualitative observations, and critical assessment thereof,

Scientific work may be performed in university institutes and other public research institutes, in public non-scientific institutions or under private auspices, and the results may be published in scientific journals or in scientific reports and reviews.

It is recommended that identical rules be applied for scientific work whether performed from research institutions in the conventional sense or from other institutions. Also, it is recommended to apply equal rules in connection with publication of scientific data whether published in scientific journals or in other ways.

These guidelines do not mention ownership of scientific data, but merely the right and duty to use them in a responsible way and have them in custody. A reason for this is that the overall ambition for research is acquisition of new knowledge and spreading of the knowledge thereof, unprejudiced and with no other restriction than as follows from quality assessment. This is incompatible with "ownership" which usually means that the owner also may destruct or keep secret research results as he or she deems appropriate. It is also incompatible with the nature of conveyance of tissue and

blood samples, etc. which the Danish patients give for the Danish health scientists aimed at a particular purpose, but not to be owned by scientists or other persons.

It has been emphasised that the guidelines are in accordance with effective rules or law, including the Danish Copyright Act and the Danish Act on Processing of Personal Data. Please refer to the references at the end of this chapter.

The guidelines only aim at rights and duties in the mutual relationship between scientists and between scientists and research institutions. It is assumed that scientific data and biological materials have been collected and filed in accordance with law and provisions in effect from time to time with respect to patient information and consent as well as filing of personal data.

1. Filing and securing of data

1.1

It is recommended that the total amount of collected data and any biological materials entering a research project be located in a central information or bio-bank at the institution or department under an institution which is home of the research. If several institutions or departments cooperate, a central information bank should be appointed which holds all data included in the common project. By prior agreement, it should be determined where such central information bank is to be placed. However, it may be agreed that special raw data or biological materials are not to be located in the central bank but are to be filed in one or several of the institutions in which they have been produced or provided.

The individual institutions or departments may furthermore file the non-biological data or copies of the data they have produced themselves. By storage of the research materials, the Act on Processing of Personal Data is to be observed, i.e., data materials are to be destructed or anonymised as soon as the permission from The Danish Data Protection Agency expires. For especially valuable bio bank collections, it may be necessary to confer with central research authorities for potential destruction.

Also, if research under an institution is carried out in cooperation with, for instance, commercial sponsors with own database, the institution ought to have an information bank holding the data produced at the institution.

Upon completion of a project, the information bank may perhaps be transferred to Danish Data Archives (DDA), which in 2004 has created DDA Health and DDA Society. Transfer for storage in archive is regulated by the Danish Archives Act (see section 14 of the Act on Processing of Personal Data).

1.2

The participating scientists shall not erase data or remove biological materials from the central information bank, but shall have free access to the information within the framework of the planned project and may have at their disposal a copy of the data they have assisted in producing by their own creative efforts. They may bring copies when the project is completed or if they leave the research cooperation before completion, unless otherwise agreed. However, all data are to be destructed or anonymised when the permission of The Danish Data Protection Agency expires.

1.3

Disposal of copy of other data than the ones the scientist himself or herself has assisted in producing by own creative efforts requires approval from the remaining members of the group of scientists.

1.4

Upon publishing of the results from a project, the institution ought to make data available to any scientist with relevant interest in and assumptions for using them – conditional upon the approval of the authorities (e.g. The Danish Data Protection Agency).

Before the results of the original research project have been published, outsiders, however, are only accessed to data if all participants of a project agree to grant permission to such access. Accordingly, institutions cannot redistribute data

without the permission of the scientists. If publishing of data is delayed, possibility of knowledge-sharing with other scientists should be opened after a suitable span of years, e.g. five years (see Chapter 5.8 about duty to publish scientific data).

With respect to personal data and sensitive information, it is a basic responsibility to comply with section 41(3) (see Chapter 7.2) of the Act on Processing of Personal Data.

2. Publication

2.1

Scientists shall have right of use of analysis and publication of the data they have produced or assisted in producing by creative efforts. However, other scientists shall only apply such unpublished data in own publications upon prior agreement with the scientists who have produced them. The scientists shall aim at publishing the finished result of their research, including the trials in which a commercial sponsor is included, irrespective of the accordance of the result with the prior expectations. Only qualitative assessments should be made. Political, administrative and scientific managers or supervisors who are not directly involved in the research process may be co-responsible for the quality of the work and the resulting publications, but they should not prevent or delay the publication for the reason that the results are unexpected or unwanted.

2.2

Universities and similar institutions usually do not exercise influence on the publishing process, but usually assume that publishing is made in scientific journals or books. Certain branches of science also publish on recognised websites. Sector research institutions and public, non-scientific institutions may have a tradition for the publication not exclusively taking place in scientific journals but also or only in reports or reviews published by themselves.

The rights and responsibilities of scientists in relation to a publication which appears scientific should be considered independent of the manner of publication.

That a project is performed in cooperation with, e.g., a commercial sponsor shall not reduce the scientists' responsibilities for analysis and publication of data (i.e. that positive as well as negative trial results are published).

2.3

The individual scientists' right of use of data should be exercised within the framework of the cooperation with the other participants according to the agreements entered into, fully open and respecting the other members' duties and rights.

On use of data, the scientists in cooperation should seek to avoid unnecessary delays.

Requests from individual scientists as to use of data for academic theses or other separate publications which were not agreed on initiation of the project should, as soon as such request arises, be disclosed to the entire group whose acceptance should be obtained. Please also refer to the limitations of the Act on Processing of Personal Data as to use of data for other research projects, see Chapter 7.

2.4

With a view to distribution, communication or publication of research results via electronic channels, the scientists are to be aware of not unintendedly including underlying, hidden data with personal data, for instance, Excel object or PowerPoint presentations (see The IT and Telecom Agency's guidelines relating to hidden data in documents (<http://www.itst.dk/it-sikkerhed/privacy/beskyttelse-af-privatlivssferen-2/Risici-ved-skjulte-data-i-office-filer>)).

3. Patenting

3.1

If scientists predict that a possibility of patenting arises, the allocation of such potential intangible rights should be decided. The agreement ought to ensure that the results are published in scientific media, but that publication will not take place until

after the patenting potential has been examined and a potential application has been submitted. A deadline should be set for such probing, usually approximately three months.

3.2

If, during the course of a project, a patenting possibility arises, and no prior agreement to this effect exists, a subsequent voluntary agreement about publication and secrecy should be attempted concluded. If the project participants cannot agree to this effect, a publication right, which would be significantly influenced by a patent case, shall be first priority, as the cooperation is to be considered to have rested on this usually applying assumption.

3.3

It is recommended that an agreement be entered into on start-up of projects as to whether patenting or publishing shall have first priority in the event of unexpected patenting potential.

3.4

Act on inventions at public research institutions and act on employees' inventions include provisions about employees' and employers' rights to inventions made in an employment. The basis is that the right to inventions is attributable to the employed scientist, but that the employer may claim transfer of such right against payment. Referring to this act, the employee is accordingly liable to report an invention made to the institution.

4. Conflict resolution

4.1

Conflicts ought to be prevented by prior agreement about allocation of work efforts and about expected allocation of rights of use and related authorships. Procedures for current adjustments of plans and for dispositions on resignation or acceptance of employees during the course of the project

should be agreed. See also Chapter 3, Guidelines on contracting on initiation of research projects.

4.2

Conflicts must not prevent the publishing of achieved results or result in deterioration in terms of quality. The right of use to data may be deprived from a scientist in breach of agreements to such degree that the remaining scientists', institutions' or funds' interests are disregarded considerably. By publishing, the scientist who is excluded may be mentioned in an acknowledgement, if he/she has contributed with data entering in the publication, and the matter shall be disclosed to the editor or the journal to which the manuscript is submitted.

4.3

If conflicts prove difficult to solve, settlement should be attempted at an early point in time with assistance from an external umpire, perhaps by mediation.

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6 Commercialization of research results and Intellectual Property Rights

Niels Lysholm Engelhard

Summary

Universities have become increasingly engaged in collaboration with industrial companies, and intellectual property rights (IPR) play an important role in this kind of collaboration. This chapter introduces the legal background to transfers of technology from universities to industry. Then it describes the two most important forms of intellectual property right, namely patents and copyright. Then there is a detailed description of how technology transfer works through the involvement of a Tech Transfer Office. Finally, there is a short account of experiences with technology transfer at University of Copenhagen.

1. Introduction

Industry depends on access to results of university research in order to develop new products, processes, etc., and thereby remain competitive. Mechanisms to support technology transfer from academia to industry have been embedded in innovation policies by almost all governments across the globe. Industry participation in publicly funded research projects has become a tool widely used by the various funding bodies, both in national research programs and in EU programs, especially as part of the Horizon 2020 program. More and more, universities and other public sector research institutions are involved not only in providing education and scientific discoveries, but also in collaboration with industrial companies.

On the face of it, this seems to conflict with the traditional role of publicly funded universities as institutions which provide knowledge as a public good for the benefit of all. The potential conflicts of interest the wider role gives rise to need careful management (see chapter 7 for more on this).

Technology transfer can take many forms, but this chapter will focus on technology transfer based on the commercialization of research results protected by IPR.

2. Technology Transfer

The transfer of technology from universities to industry really took off with the 1980 Bayh-Dole-Act in the US, which stated that the *universities* have the right to take ownership of inventions made by the employed researchers. Before 1980, in the US, researchers themselves had ownership of any of their own inventions made as part of their work. This was called “Professor Privilege”.

Denmark’s own “Bayh-Dole-Act” – the Act on Inventions at Public Research Institutions – was passed in 2000. Before then researchers at Danish universities and other public sector research institutions had ownership of their own inventions.

Why should university researchers not just publish new knowledge so that anyone, including industry, may benefit from the knowledge thereby made available? Imagine having invented a new molecule that could be a wonder drug for the eradication of HIV or tuberculosis. Would it not be more ethical to publish the technology so that anyone can use it?

The problem is that it takes years, and vast funds, to develop and market a new drug (or other high tech products for that matter). Therefore, no investor or company would take on the risk of developing and commercializing a new product or technology without the protection offered by a patent to secure a return on that investment. Hence, if technology is to be made commercially available, a property right to the invention may be necessary.

Companies will invest in products for which there is a probably going to be a demand. Patents may help to ensure that those making this demand will benefit. However, there are also areas which are not commercially interesting, but where new knowledge may be beneficial – e.g. to people living in impoverished parts of the world. Universities also have an obligation to benefit these people.

Hence, there are important priorities involved in technology transfer and how it is managed. Governments encourage technology transfer, because it is a way to supply innovation to industry and create new jobs. For universities, industrial collaboration offers opportunities for extra funding; moreover, through it, researchers may gain access to otherwise unobtainable knowledge and equipment. However, universities have obligations that go beyond what can be achieved through commercialization – e.g. finding cures for very rare diseases of little commercial interest, or helping people to find healthier ways of living. Therefore, a reasonable balance between research focused on commercial applications and other kinds of research is called for. Also, industry collaboration should not jeopardize the freedom of research.

The effective transfer process is in essence about people interacting so that innovation can occur. Intellectual property rights may just be viewed as tools, and legal agreements can be seen as a framework to support the collaboration between academic scientists and industry. The process is not always easy, as academia and industry belong to different worlds. Understanding the viewpoint of the other party is the key to success. The primary mission of a university is education, and the creation and dissemination of new knowledge for the sake of knowledge itself, with publishing as a fundamental condition. Industry's mission, by contrast, is to make a profit by providing services and offering products to the market. The knowledge lying behind these services and products is for the most part developed confidentially in-house.

3. Intellectual Property Rights

Intellectual property rights confer ownership on ideas and creations and grant the inventor/creator exclusivity for a certain period of time. They are instrumental in driving forward the development of technology and innovation.

IPR divide into two categories:

1) *Industrial Property Rights* include patents and utility patents, trademarks, industrial designs and geographical indications.

2) *Copyright* covers literary and artistic works such as articles, theses, films, photographs, musical compositions, drawings and paintings, sculptures, and architectural designs. The rights related to copyright include those of performing artists in their performances, and those of producers of phonograms and broadcasters in their radio and television programs.

This chapter will focus on patents, utility patents and copyright, since these are the most relevant types of IPR for public sector researchers.

3.1 Patents

A patent covers the technical aspects of an invention – it is, in other words, a technical solution to a problem. The owner of a patent can block others from commercial exploitation of the invention; at the same time anyone is permitted to perform research on the invention for non-commercial purposes. Patent rights are territorial rights. If a patent is only granted in Denmark, anyone can exploit the invention in other countries outside Denmark, although they cannot export products or semi-manufactured products that are based on the invention to Denmark. There is no “patent police”. It is the owner of a patent who must protect his or her rights against infringement.

Criteria governing the issuing of a patent are:

- 1) Novelty
- 2) Inventive step
- 3) Industrial applicability

Novelty means that the invention has to be novel at the date the patent application is filed. Meeting the novelty criterion is an objective and a global matter. If an invention has been presented in a public forum, described in a paper, journal, or on the internet, or in any other way, it is not possible to obtain a patent unless the patent application is filed before the invention was published. Discussing the invention in a closed circle – e.g. with supervisor and close colleagues – does not destroy the novelty of the invention, nor will the submission of a manuscript to a journal provided the manuscript is kept confidential during the review process and a patent application is filed at least one day before the paper is published. Thus, patenting will not hinder or prevent publishing – it is only matter of timing.

Inventive step means that the solution presented by the invention must not be obvious to a person with knowledge within the technical field of the invention who has all of the published relevant information at hand. The combination of two or more already published documents, such as a scientific paper combined with a text book or patent, may render the invention obvious.

Industrial applicability means that the invention can be made or used.

A patent provides protection for 20 years from the date the patent application was filed. Anyone can exploit an invention freely after expiry. Twenty years is a long time in some technological areas, but not in the pharmaceutical or pesticide industry, where it takes 10-13 years from initial filing of first patent application to the product's being ready for launch in the marketplace. The long development phase leaves the company with only 7-10 years to get a return on its investment before the patent

expires. An annual fee is paid for each country in which the patent is in force. The patent protection will lapse in a country if the fee is not paid.

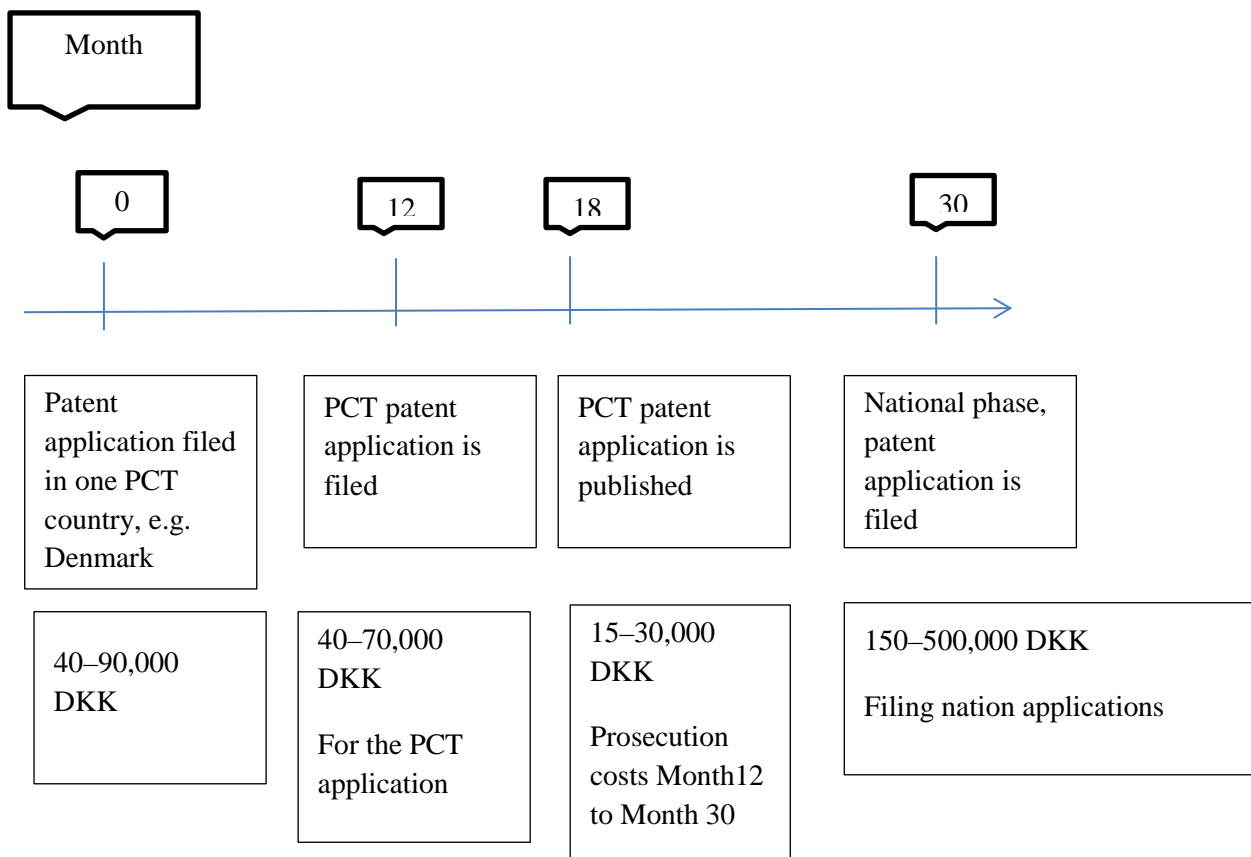
A patent application can be filed for four types of item:

- Subject matter (e.g. a compound, herbicide or drug)
- Process or method (e.g. a process for the extraction of specific compounds, or for manufacturing a product)
- Machine or article of manufacture (e.g. a new tool)
- Use (e.g. a drug developed against one disease may show effectiveness against another disease)

A plant or animal that can be found in the wild is not patentable. However, a transgenic animal such as the Oncomouse may be patentable in certain countries such as US; the same is true of genetically modified (GM) plant varieties – e.g. a GM wheat variety. Inventions contravening public policy or morality (e.g. a torture instrument) cannot be patented.

It is very costly to file the first patent application in many countries, and this imposes a heavy burden on companies and institutions. This could be detrimental to innovation, as there is often long journey between the first filing and the final product. Thus, several regional and global patent treaties make it possible to postpone costs while working to obtain a patent. This allows an inventor or company several years to complete prototyping and business planning before the application process becomes costly, as outlined in Box 1 below. One of the most widely used systems is the PCT (Patent Corporation Treaty) system, which is operated by the United Nations.

It usually takes 3-4 years, from the date of the initial filing of the application, for the patent to be granted. The route from patent application to granted patent, including costs in DKK, is outlined below:



This overview clearly shows the expense of the route from patent filing to granted patent. The precise cost depends on the complexity of the invention and field of technology.

Inventorship is credited to one or more individuals who have contributed intellectually to the conception of the invention and the technical means of the invention (the “how”). An individual cannot be an inventor if he or she merely follows a protocol designed by others, comments on the text of a draft patent application, provides funding for the research project leading to the invention, or has a senior or management role. Adding people to the list of inventors who are not really inventors, or omitting inventors from the list, can lead to problems for the patent owner and even result in the invalidation of a granted patent. In cases of doubt, inventorship can be determined with the assistance of a patent agent.

Box 1

More information on patents can be found here: www.wipo.org, www.epo.org and www.dkpto.dk.

Knowledge created by companies is often not published in journals, but the information is available in the patent literature. Patent applications are published 18 months after the first filing date, and the patent literature offers researchers a rich source of knowledge and “how to” which can be used freely for research purposes as long as the research is *into* the invention and not using the invention as a tool in research project. Thus research into, for example, the PCR method, if that method is the subject of the research project, would not infringe the PCR patent, but using the PCR method as a tool instead of buying the PCR product would constitute an infringement. Business intelligence on competing groups or companies can easily be carried out by a search of the patent literature. There are several free databases available on the internet. www.google.com/patents and www.espacenet.co.uk are both excellent databases.

3.2 Copyright

Copyright differs from the industrial property rights (patents, trademarks and design registration) in many ways. The copyright symbol © is still widely used, but in fact it is not necessary, as copyright is automatically given by law without any application process. Copyright also differs from industrial property rights in that with it the creator of the copyrighted item, who is always an individual, holds the right to his or her work. Furthermore, a work has to represent “originality” to enjoy copyright protection.

The Danish Copyright Act (“Ophavsretsloven”)⁸ regulates the protection of two categories of subject matter (or types of creation):

1) *Literature and artistic works* such as maps, drawings, computer programs, architecture, various expressions of art (fictional or non-fictional), applied art, works of fine art, and graphic works.

⁸ www.retsinformation.dk, search for LBK nr 202 af 27/02/2010

2) *Neighboring rights* such as photographs, films, movies, sound recordings and music, and the performance of literary or artistic work such as theater plays.

The protection afforded lasts for 70 years after the death of the creator in the first category and 50 years in the second category.

The creator has the right to reproduce (copy), alter, disseminate, and perform or show or display his or her work. These rights can be assigned to a third party such as a journal or publishing company. Researchers and teaching staff hold the copyright to any material (except computer programs) that fulfill the criteria for copyright protection. I have copyright to the text in this chapter; however, my employer has the right to use the text even if I leave my position.

Computer programs are protected by copyright. The protection relates only to the actual code (the binary sequence of “0” and “1”) and to graphical representations such as the layout of the graphical interface, including icons and drawings – not to the algorithm in itself. Who owns a computer program made by a researcher at a public research institution in Denmark? Unlike inventions, the employer (institution) automatically has ownership here.

A work that enjoys copyright may consist of two individual works, e.g. a photo of sculpture presented in PowerPoint. The creator of the sculpture still has copyright to his work, the photographer holds copyright to the photo, and maker of the PowerPoint holds the copyright to the PowerPoint slide. In this case, the last of these creators would need permission, or a license, from the photographer and artist, or from an organization to which the artist and photographer have assigned their right to reproduce or otherwise use the creation.

It should be emphasized that copyright protection only applies to the work itself, not to the idea or theory presented in the work – e.g. to a new theory in given scientific field.

Box 2: Tips

- Never use photos, drawings, or other copyrighted material without obtaining permission from the rights holders
- Do not assign all your rights to publishing companies or other organizations without having read the guidelines: Copyright for researchers, students and teachers at University for Copenhagen, <http://kubis.kb.dk/copyright>
- UBVA (Udvalget til beskyttelse af videnskabeligt arbejde) offers free guidance, an e-book on copyright (in Danish), and free online courses in copyright (www.ubva.dk)

4. How does technology transfer work?

Collaboration with external partners is an integrated part of working at a university or other public research institution. The collaboration can take many forms and is regulated by different types of legal agreement. Technology transfers are usually organized in specialized Tech Transfer Offices. In order to avoid problems employees should always consult the local legal advisor at the individual faculty, or contact the Tech Transfer Office for assistance.

The Tech Transfer Office *at the University of Copenhagen* operates from Research & Innovation, in the university's Central Administration (Fælles Administrationen). All matters relating to the commercialization of IPR at the University of Copenhagen are handled by the Tech Transfer Office, which also assists researchers in entering all types of legal agreement.

You are not permitted to sign an agreement between the University of Copenhagen and external partners. The agreement must be negotiated by the Tech Transfer Office and signed by your head of department. If you need more information, there is a booklet introducing the overall principles of the university's collaboration policy at <http://www.fi.ku.dk>. The booklet is available in Danish and English.

Inventions made by researchers at Danish universities, university hospitals and other public sector research institutions are regulated by the Act on Inventions at Public Research Institutions (Lov om opfindelser ved offentlige forskningsinstitutioner). If an employee has made an invention as part of his or her work, the research institution has a right to transfer to itself the rights attached to the invention. All tangible materials – e.g. antibodies, seeds and microbial strains – belong to the institution and can in principle be commercialized under a license agreement or sold. However, the Act only gives the institution the right to inventions falling inside the researcher's field of work at the institution. For example, if a cancer researcher invents a patentable new kitchen tool, that tool will not be considered an invention subject to the Act.

The definition of “inventions” is stated in the “The Patent Act” (Patentloven), and The Act on Utility Patents” (Brugsmodelloven). The inventor must report (disclose) the invention to the Tech Transfer Office. This is done by completing an Invention Disclosure Form. Under the Act on Inventions at Public Research Institutions the research institution has a two-month period after the date of disclosure to decide whether to assume the rights to the invention. Inventors are not entitled to publish or otherwise disseminate information relating to the invention during this assessment period. If the Institution fails to notify an inventor of their decision within the two-month period, the inventor retains the rights to his or her invention as a private individual.

Where the institution decides to assume rights over the invention those rights become the property of the institution. If the invention is exploited commercially, the employee will be entitled to a reasonable payment from the institution. That payment is described by the Act, where details of how net income is to be calculated are given; but each institution has the right to decide how they distribute net income between the institution, the departments and inventors.

Sometimes an invention involves inventors from more than one institution, as well as inventors from a company. In such cases the invention will be co-owned and a patent co-ownership agreement will be signed between the parties. The proportion of ownership will, unless otherwise agreed, be based on the intellectual contribution of each inventor to the invention. It is highly advisable therefore that all inventors agree on the distribution rubric internally as soon as possible, and preferably at the time when the invention is disclosed to the institution.

Box 3: Distribution of the net income from inventions at the University of Copenhagen

Net income is defined as gross income (e.g. royalties received) minus external costs incurred during the commercialization of an invention (including patent costs and travelling expenses). Once the total costs for commercialization of the invention have been recouped, the net income will be distributed in the following manner:

If the University of Copenhagen assumes the rights to an invention before the end of the two-month period:

1/3 to the inventor(s)

1/3 to the department(s) where the inventors are employed

1/3 to the University of Copenhagen

If the University of Copenhagen decides not to assume the rights to an invention within the two-month period and offers the rights of ownership to the inventors:

The University of Copenhagen is entitled to 1/3 of net income

The University of Copenhagen offers the inventors to reclaim the ownership to an invention after having tried to commercialize it:

The University of Copenhagen is entitled to a share of the net income subject to individual agreement on a case by case basis

Bachelors and Masters students are not subject to the Act on Inventions at Public Research Institutions in that the Act does not apply to inventions created as part of their studies as private individuals. If a Bachelors or Masters student becomes a co-inventor by participating in a research project, the institution may enter an agreement with the student under which the student assigns his or her share of the rights to the invention to the institution in return for a share of the net income.

If a University of Copenhagen Bachelors or Masters student becomes a co-inventor through his or her participation in a research project, the Tech Transfer Office will ask the student if he or she wishes to assign his or her share of the invention to the University of Copenhagen as if he or she was an employee of the University of Copenhagen. It is recommended that an assignment and confidentiality agreement with the student should be set up as part of a research project involving industrial partners. Contact the Tech Transfer Office for help and guidance.

Box 4: More information:

LBK nr 210 af 17/03/2009 to be found at www.retsinformation.dk and <http://ubva.dk/Patentret>

4.1 The two-month period

Each institution has its own procedures and forms for the disclosure of an invention. Once formalities are in place, the invention is assessed and evaluated before the institution decides whether to assume the rights to the invention and file a patent application. Essentially, the decision is based on answers to the following questions:

- 1) Is the invention new and patentable?
- 2) Does the invention hold a commercial potential?
- 3) Can it be commercialized (sold or licensed)?

The first question, relating to patentability, is assessed by an external patent agent who not only understands the specific field of technology, but is also a specialist in IPR and patent law. One of the prerequisites for obtaining a patent is that the invention must be novel. This means that the invention must not have been made available before to the public anywhere in the world. The patent agent conducts a search in the patent literature and the scientific literature to identify documents or other material that may destroy the novelty of the invention and thus prevent the invention from being patented. This process usually requires input from the inventors, who assist the patent agent in fully understanding the technology, defining the invention and setting up a proper search profile. The review and assessment of patentability is stated in a written report.

The Tech Transfer Office reviews the commercial potential of an invention by benchmarking it against similar technologies or products currently available in the marketplace, and by contacting relevant companies and other commercial players (without disclosing the invention) to assess the commercial potential of the invention. For some inventions, an examination of the regulatory landscape surrounding the technology may be necessary in order to identify potential barriers to the commercialization of the invention such as industry standards or customs in the trade. The inventors play an important role in assisting the Tech Transfer Office with any technical input needed in the evaluation of commercial potential.

To answer the question whether an invention can be commercialized it is necessary to consider a number of issues: the developmental stage of the invention, the internal resources (funding, capacity of potential inventors, and availability of equipment) it will require, the availability of relevant potential industrial partners, and time and funding constraints, both internal and external. The Tech Transfer Office investigates these issues in close collaboration with the inventors.

Following the investigations outlined above, the Tech Transfer Office will decide to either assume or decline to assume rights to the invention from the inventors. In the first of these outcomes, a patent application will be drafted and filed, and commercializing activities will begin. The patent applications are drafted by an external patent agent in close collaboration with the inventors.

4.2 The commercialization period

After the patent application has been filed commercialization activities begin. There are basically two routes to commercialization for university IPR:

- 1) License or sell the IPR to an existing company
- 2) Establish a spin-out company founded by the inventors or a wider group of inventors

Under the Act on Inventions at Public Research Institutions, an institution may sell or license IPR to industry partners, license IPR to a spin-out company or receive shares in a spin-out company, or both, in exchange for IPR generated at the institutions. Each Danish university has its own business strategy. Some institutions sell IP rights, some only out-license IPR, yet others receive shares for equity in start-up companies originating from the institution as the preferred strategy. Institutions may employ a combination of these strategies.

Box 5: IPR and business strategy at the University of Copenhagen

The University of Copenhagen:

- 1) only invests in patent applications with a likelihood of being commercialized
- 2) does not sell IPR or accept shares in spin-out companies in exchange for them
- 3) maintains ownership of IPR and licenses them to external or spin-out companies

Before a potential industry partner is approached, a non-confidential description of the invention and business opportunity will usually be drafted by the Tech Transfer Office and the inventors in collaboration. There are several ways in which to identify the appropriate industry partner. The inventors may be familiar with relevant companies, or the Tech Transfer Office may be able to identify and contact relevant industry partners. Face-to-face presentation of the invention to a potential external partner is headed by the Tech Transfer Office with the assistance of the inventor(s).

Although a given technology can in principle be sold or licensed to more than one company, the majority of commercial agreements involve one company obtaining exclusivity for the technology. The commercial partner (or licensee) pays the ongoing patent costs as part of the license agreement and will therefore almost always demand exclusivity in exchange.

When commercialization of the invention is unsuccessful the institution will offer to hand back, or return, the rights to the invention to the inventors, including the right to make a patent application which will then no longer be supported by the university's Tech Transfer Office.

Luckily inventions from the University of Copenhagen do find their way to partners in industry. This can mean both some initial income, sometimes modest, for the inventors and an intensified collaboration with the industrial partners, often leading to more funding and greater access to skills and equipment in the industry.

The University of Copenhagen received 40 to 77 new invention disclosures a year between 2009 and 2013, and rights to the invention were assumed in 20-30% of cases, resulting in 15-26 license and sales agreements a year. In comparison, 291 to 498 new invention disclosures were filed with the Danish universities and other research organizations in the same time period, resulting in 103 to 120 license and sales agreements. As show in Figure 1 below, while the number of invention disclosures and new patent applications has been rising, the number of the license and sales agreements has not gone up to the same extent. This is the result of the time-lag between an invention being disclosed and the license or sales agreement being signed.

Patent expenses are roughly equal to income between 2009 and 2013, but the net profit here does not represent the real value of technology transfer the university. In most cases a license or sales agreement entails collaboration with the industrial partner which generates more funding and new equipment. In some cases, the inventors has raised double-digit millions in research grants, so it is a win situation for both the university and the individual inventor, even if the industrial partner does not succeed in commercializing the invention.

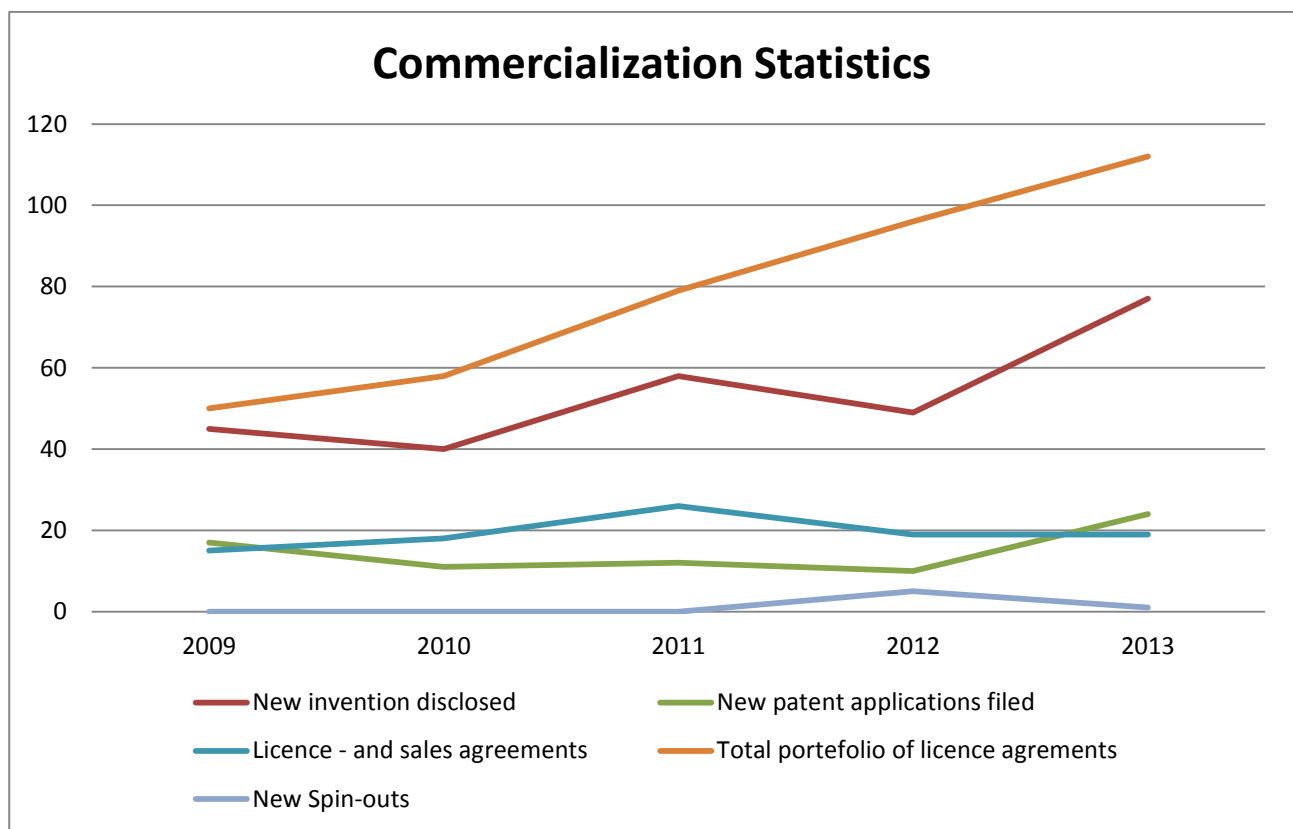


Figure 1. Commercialization Statics, University of Copenhagen 2009-2013

5. Further information or help

Visit www.fi.ku.dk

Contact the Tech Transfer Office by e-mail: techtrans@adm.ku.dk

Employed within Capital Region of Copenhagen? Visit www.regionh.dk/til-fagfolk/forskning-og-innovation

6. Test yourself questions

- Who owns innovations created at a Danish university?
- Is there a copyright to scientific work?
- How can a university innovation be patented?

7 Conflicts of interest

*Jeppe Berggreen Høj and Louise Whiteley*⁹

Summary

Scientists are driven by many interests, ranging from the goal of doing good science to financial incentives, personal commitments, and career development and the pressure to publish. When these interests compete with each other, pointing towards different actions or decisions, the scientist has a ‘conflict of interest’. This chapter begins by looking at how ‘conflict of interest’ is defined in documents relevant to academic research. It then outlines possible consequences of conflicts of interest and asks how we can decide when conflicts of interest require a response. In the light of the rules and guidelines that apply, we go on to discuss how we can evaluate and manage conflicts of interest, and how this relates to young researchers’ work.

The chapter lays out four main kinds of response to conflicts of interest: managing the potential consequences of conflicts of interest via disclosure, reducing financial conflicts of interest via formal restrictions, eliminating conflicts of interest via ‘recusal’, and adopting an open and reflective attitude to the existence of conflicts of interest and their possible effects.

Key take-home points include the following: conflicts of interest are widespread and often inevitable, but they do not always lead to improper conduct. Conflicts of interest need to be managed in order to protect both the integrity of scientific research and trust in science.

1. Introduction

Scientists do science for many reasons. Many are driven by curiosity, by a desire to advance our understanding of the natural world or its human inhabitants. For many scientists the quest for knowledge is also associated with a desire to improve the world, either directly through applied research or indirectly by contributing to ‘blue skies’ knowledge that may have practical applications in the future. But scientists also want to get paid at the end of the month, be recognized by their peers, pursue promotions and secure permanent employment, support their students, and obtain funding for their next project. They might also have personal interests in scientific questions such as the cause or treatment of a particular disease, and many would admit to a competitive streak – the rewards of being recognized in your field and in the public domain can be great, and can inspire great work.

Thus science does not only consist in the intellectual work of designing, conducting, analyzing, and publishing experiments – being a scientist is a profession, embedded in the ordinary world of jobs, salaries and career prospects. Like other professionals, scientists pursue a great variety of interests and sometimes different interests clash with one another.

⁹ The authors would like to thank Peter Sandøe for his contributions to the content of this chapter.

For example, trying to be an independent scientist of unimpeachable integrity can sometimes conflict with the need to take into account the opinions and approval of funders. Clearly, where scientists' eagerness to please funders leads them to distort their findings, they are committing research misconduct. It is important to recognize, however, that having a conflict of interest does not *in itself* constitute misconduct. Nor do conflicts of interest always lead to improper conduct

Conflicts of interest are thus all around us, and not just in high profile cases where a (typically financial) conflict of interest is cited to explain research misconduct. Conflicts of interest are also increasingly inevitable in today's scientific environment, where competition is high and academic institutions are strongly encouraged to work with private and industry funders (see Chapter 4).

In this chapter we discuss how conflicts of interests can be defined, recognized, evaluated, and managed. As with many of the topics in this book, it can be easy to state general principles, but tricky to apply them in practice. We therefore use fictional case studies to make abstract definitions and principles a little more concrete, and to explore grey areas.

There is no one definitive document on conflicts of interest, but we discuss some key local, national, and international guidelines and include further references to relevant documents (Section 5) and some research literature and journal editorials that interested readers can pursue further (Section 7). We also include some simple practical tools to help readers think through conflicts of interest in their own scientific lives.

2. What is a conflict of interest?

Some important definitions of a conflict of interest are given in Box 1.

Box 1: Definitions of conflict of interest

1) According to the Danish National Code of Conduct, a conflict of interest is “a situation in which financial or other interests have the potential to compromise or bias professional judgment.” (<http://ufm.dk/publikationer/2014/filer-2014/the-danish-code-of-conduct-for-research-integrity.pdf>, p. 15)

2) According to Thompson, writing in the *New England Journal of Medicine* in 1993, a conflict of interest is “a set of conditions in which professional judgment concerning a primary interest (such as patients' welfare or the validity of research) tends to be unduly influenced by a secondary interest (such as financial gain).” (p.573)

3) According to MacDonald et al., writing in the *Journal of Business Ethics* in 2002, “We can define a conflict of interest as a situation in which a person has a private or personal interest sufficient to appear to influence the objective exercise of his or her official duties as, say, a public official, an employee, or a professional” (p.68)

These definitions all refer to the idea of a primary, professional, or official duty to act, or exercise judgment. However, it isn't easy to define a single, primary interest for scientists – they have many different professional duties, and different scientists would probably pick different duties as the most important. For example, in Thompson's definition, a medical researcher might have both patient welfare and the validity of research as 'primary' interests. For the purposes of this book, we state broadly that the professional duty of a scientist is to advance scientific knowledge through accurate reporting of findings and valid scientific reasoning as defined by principles of good scientific practice. However, as should be clear to readers of this book, what exactly that means is continually debated, and this leaves room for interpretation of when exactly good scientific practice is compromised by other interests.

What kinds of interest or commitment could come into conflict with a scientist's primary professional duty? Common examples include:

- Personal financial gain (e.g. increased salary; increased value of personal investments in companies related to the research)
- Professional financial gain (e.g. funding for current or future research projects)
- Alternative professional commitments (e.g. commitments to a spin-off company)
- Career interests (e.g. achieving tenure)
- Professional relations (e.g. supporting students' or collaborators' careers)
- Personal relations (e.g. helping a friend)
- Religious, moral or political commitments (e.g. honoring a religious position by avoiding stem cell research; suppressing data on climate change until after a key convention of a political party with a skeptical agenda)

Among the diverse array of conflicts of interest, *financial* conflicts of interest have been given particular attention – they are considered highly likely to influence a scientist's actions. We therefore consider them in a little more detail here.

Personally, scientists can have interests in direct financial gain – e.g. through stock ownership, consultancy work, spin-off companies, secondary employment, etc. If returns on investment or payments are dependent on the results of the scientist's own research, there is a clear conflict of interest. There have been several studies showing correlations between financial investment and the results of research (see e.g. Bekelman et al., 2003; Ridker & Torres, 2006; Lesser et al., 2007; all cited in Goozner et al., 2008).

Outside of direct personal financial gain, scientists are continually faced with the challenge of securing funding, and the results they obtain can have a more or less direct influence on their chances of doing so. If a private sponsor has an interest in a particular result, the conflict of interest is very clear. But even if the research is paid for by a source that has no interest in the *direction* of the results, getting *some* results – and preferably important and novel ones – may well influence the likelihood that the scientist will obtain further grants. Even less directly, all scientists have an interest in ensuring that political processes and public opinion favor the future supply of funding.

Naturally, these pressures can affect decisions about such matters as how to target research resources and publications.

Box 2 contains three fictional cases illustrate different kinds of interest and how they might conflict in determining a scientist's actions. We will return to these examples throughout the chapter, and consider the consequences they might have and how these can be managed. For now, see if you can summarize which interests or duties conflict in one sentence for each case.

Box 2: Example cases

1) John, a final year PhD student, is eager to achieve recognition from his colleagues and maximize his chances of getting a good postdoctoral position. He has been advised by his supervisor that the one thing missing from his CV is a publication in a high impact factor journal. John has collected data that suggests a hypothesis commonly accepted in his field is false – the kind of result likely to catch the attention of *Nature* or *Science*. However, there are a few data points that prevent the relevant comparison from reaching statistical significance, and John wonders if collecting more data would allow him to conclude that these data points are statistical outliers.

2) Anjali, who is a postdoc, is in a team of three researchers being paid to estimate the impact that building a new bridge would have on the local fauna. The results will help determine exactly where the bridge will be placed. Anjali and her partner own a summerhouse on the beach close to where the bridge may be placed, and very much hope that the bridge will be placed elsewhere, as it will decrease the value of their property. Anjali will be involved in making observations of the local fauna that cannot be fully automated and quantified.

3) Lone, an assistant professor, is part of a research group that receives a significant share of its funding from a large Danish medical company. They are currently testing one of the company's promising new drugs for diabetes. Their preliminary data indicate that the drug may have unforeseen side-effects that could significantly delay its market introduction. Lone worries that the company may discontinue the funding they have provided so far, which could lead to staff cuts in Lone's research group. Lone is the only one who has seen the preliminary data.

As the three examples in Box 2 show, conflicts of interest are highly diverse. They range from professional and financial interests to personal or moral commitments, including the drive for collegial respect (John), financial security (Anjali) or job security for one's colleagues (Lone).

To bring some order to this diversity, it can be useful to clarify some of the key features of conflicts of interest:

- First, conflicts of interest span the entire research process, not just the results stage. They might arise when a scientist is conceptualizing and designing experiments; performing data collection, modelling, or analysis; preparing and publishing articles; or presenting results and their implications in professional and public forums. They can also arise in relation to the many other functions that a scientist performs,

from acting as an expert reviewer to training and teaching students, contributing to decisions regarding recruitment and funding, and so on.

- Second, conflicts of interest are not just about the individual's self interest – many are about commitments to others, or duties to a group or collective such as a lab, a research field, or even to the wider society.
- Third, it is important to note that 'good science' can itself involve a clash of interests. For instance, it is often unclear when the aim to publish results quickly in order to advance the progress of science trumps other aims such as ensuring that results are as solid as possible before publication.

3. The consequences of conflicts of interest

Thompson's definition in Box 1 describes a conflict of interest as a set of conditions that *tend* to influence scientists to act against their primary duties – as we have seen, the existence of a conflict of interest doesn't in itself constitute or necessarily lead to misconduct. So when should we worry? If there is nothing inherently wrong with scientists being motivated both by their professional duties and their personal interests (Steneck, 2007; p.68), how do we know when this *is* a problem? Deciding when conflicts of interest are problematic requires us to consider both the potential severity of the consequences, and the likelihood of them occurring. We can then consider how to manage or eliminate conflicts of interest deemed to be problematic (see Section 4).

3.1 Conflicts of interest can lead scientists away from responsible research conduct

The most serious problems arise when scientists resolve the conflict between different interests in a way that departs from their professional duty to produce valid research. As mentioned above, many studies have shown correlations between authors' financial conflicts of interest and the outcomes of research. However, as earlier chapters have explored, there are more or less serious ways in which scientists may diverge from responsible research conduct. Thus, problematic consequences of conflicts of interest might range from relatively minor issues, such as sitting on data a little too long or letting the interest of a funder influence the direction of one's research, to forms of research misconduct such as fabrication or ethical violations.

To return to our cases (see Box 2), John's conflict of interest might lead him to discard the outliers in order to make the finding statistically significant, which would clearly constitute research misconduct. But he might also decide to run another experiment to see if that changes the conclusion, which could fall into a grey area.

If Lone hid data on dangerous side-effects to protect her research staff she could be prosecuted for misconduct, but if the side-effects were not serious and she sat on the data just long enough for her staff's contracts to be renewed, an evaluator may decide that her actions stopped short of research misconduct.

Scientists whose decisions, judgments, or actions are biased away from responsible research conduct by a conflict of interest may not be consciously aware of it. For instance, in collecting and analyzing qualitative observations of the local wildlife Anjali might overstate the expected negative

impacts of the bridge without realizing she is doing so. If Anjali was later accused of misconduct, whether she had *intentionally* biased the data would be an important question for an evaluator to consider. And even if they concluded that she had no intention to misrepresent, she would still have the duty to declare her conflict of interests (see Section 4.1 and 4.3) or even remove or (in the technical jargon used here) ‘recuse’ herself from the project (see Section 4.4).

3.2 Conflicts of interest can undermine trust in science

In Box 1, MacDonald et al. (2002) state that a conflict of interest exists when a competing interest is sufficient to “appear to” influence a professional’s ability to exercise official duties, highlighting the importance of appearance. Even if Anjali *wasn’t* influenced by her conflict of interest, if she failed to disclose it and a newspaper picked up on the story, it could damage both official and public trust in the results of the study and the reputation of the researchers.

Across many parts of contemporary society, science has a special status as a source of knowledge about the world. Humanities and social science scholars have long questioned and investigated the degree to which science provides impartial, objective, and trustworthy knowledge (see Box 3), but it is widely believed that science tells us how things are rather than how someone wants to present them as being. This gives scientific results significant weight in relation to important societal decisions, as well as justifying the financial prioritization of scientific organizations and projects, and investment in applications and technologies based on scientific knowledge.

For science to maintain its status it is crucial to maintain or improve public trust, and nurture the belief that scientists generally act responsibly and produce valid research (see more on the issue of public trust in science in chapter 8). But conflicts of interest can undermine just that belief. The consequences can be local, such as discrediting an individual scientist. But they can also be more far-reaching. For example, if many studies of climate change were found to involve conflicts of interest, this could damage perceptions of the entire field and its ability to inform important societal decisions. This raises the question of whether conflicts of interest always should be made public (an issue we return to in Section 4).

Box 3: The Nature of Science

It is important to acknowledge that the idea of science as a source of totally impartial and objective knowledge is a simplification. What kind of knowledge is produced by scientific research is a central topic of investigation for philosophers, sociologists, ethicists, and historians of science, as is the degree to which scientific practice is influenced by social contexts, and the ways in which scientific knowledge does and should influence social and political decisions. Setting aside the more abstract philosophical discussions that can seem far away from the scientist’s everyday work, many scientists themselves would acknowledge that the processes through which research is funded, how that research is then designed, and how the results are applied and understood, are rarely wholly impartial.

These topics are dealt with in theory of science courses (good introductions can be found in Hanne Andersen, et. Al., 2006 and A.F. Chalmers, 1999). But thinking about conflicts of interest also reminds us that these philosophical and sociological questions are ultimately about the reality of scientific practice; about the way that the world outside the lab is entangled with the scientific process. Such thinking challenges researchers to consider how they can nonetheless justify and follow their field's norms, methods, and ethos.

3.3 When are conflicts of interest significant enough to require a response?

Above we have explored potential negative consequences of conflicts of interest for research integrity (Section 3.1) and for trust in science (Section 3.2). What this doesn't tell us is how to judge the likelihood and severity of these negative consequences. Or in other words, whether a conflict of interest is 'significant' enough to require a response. Three considerations help to answer this question:

- 1) *Contextual requirements*: In some cases there will be rules or guidelines that tell you whether a conflict of interest is significant enough to require a response, and also what to do about it (see below). There may also be relevant local traditions or rules set down by your employer. For PhD students employed by the University of Copenhagen, the most important of these rules and guidelines are listed in Section 5 and excerpted in Box 4.
- 2) *Your personal judgment*: There are bound to be conflicts of interest that are not covered by rules or guidelines, or cases where it is not 100% clear how to apply rules. Here, honest reflection on whether a conflict of interest is likely to influence you is crucial, and personal judgment can be cultivated over time, through private reflection and discussion with others.
- 3) *The judgment of others*: Colleagues, supervisors, the 'Named Person'¹⁰, at your faculty, and professional independent advisors can all give useful advice on whether a conflict of interest is significant enough to require a response. This can also be a useful way of working out whether the mere appearance of conflict of interest would be damaging – how likely is it that others will assume you have been unduly influenced?

4. How to handle conflicts of interest

In this section we consider what should be done when a conflict of interest is judged to need a response – by you, by others, or by the institution where you are conducting your research. Responses range from managing potential consequences of conflicts of interest via disclosure (4.1) or discussion (4.2), to reducing them through financial restrictions (4.3) or eliminating them through recusal (4.4). This topic is also discussed (with a focus on US rules and legislation) in the ORI¹¹ Introduction to the Responsible Conduct of Research (Steneck, 2007). Box 4 provides an excerpt

¹⁰ For the Faculty of Health and Medical Sciences see <http://healthsciences.ku.dk/research/responsible-conduct-of-research/namedperson/>. For the Faculty of Science, see http://www.science.ku.dk/english/research/good-scientific-practice/named-persons_/

¹¹ 'ORI' refers to the US Office for Research Integrity

from the new Danish Code of Conduct for Research Integrity (p15), giving the current position for researchers working in Denmark. Note that the Code focuses not only on what should be done, but also on whose responsibility it is to do so.

Box 4

6.1. Responsibilities

- i. All parties involved with the research in question should disclose any conflicts of interest.*
- ii. Assessors of research and research proposals (e.g. editors, reviewers, research councils, etc.) who have a conflict of interest should withdraw from any involvement in the process.*
- iii. All parties involved with the research in question have a joint responsibility for handling issues relating to conflicts of interest.*

6.2. Division of responsibilities

- i. **Researchers** are responsible for disclosing all conflicts of interest related to the research they are involved with.*
- ii. **Institutions** are responsible for addressing conflicts of interest, and for ensuring that all conflicts of interest are handled adequately. In this context institutions should have a policy for handling conflicts of interest, which includes information on:*
 - a. Situations that constitute a conflict of interest*
 - b. Disclosure of conflicts of interest, including how to handle confidentiality issues*

4.1 Disclosure: Declaring conflicts of interest

The excerpt from the Danish Code of Conduct for Research Integrity in Box 4 states that the main responsibility of researchers is to always disclose any conflicts of interest,¹² and to withdraw from assessment processes when they doubt their ability to act impartially. It is primarily the responsibility of the various relevant institutions (e.g. universities, journals) to *handle* conflicts of interest¹³, though the code also emphasizes that there is a ‘joint responsibility’

The form of disclosure young researchers are most likely to have encountered is being asked by a journal to declare conflicts of interest when submitting a paper for publication. This is one, key way

¹² As discussed in Section 3.3 there are some conflicts of interest that are so small, or so generic to being a scientist, that they may be taken to lie outside of this protocol. Or in other words, in our terminology the code is understood as reading ‘any *potentially significant* conflicts of interest’.

¹³ For an example of how universities handle this, see the University of Copenhagen rules on external activities (listed in section 5).

of stating your conflicts of interest in a public forum. The basic rationale behind disclosure is transparency: it should be left to the reader to judge whether the results appear trustworthy or unduly influenced by conflicting interests. As stated in the Vancouver Recommendations (pp. 3-4), quoted by the Danish Committees on Scientific Dishonesty:

“Public trust in the scientific process and the credibility of published articles depend in part on how transparently conflicts of interest are handled during the planning, implementation, writing, peer review, editing, and publication of scientific work.”

As we saw above (3.2), transparency is widely believed to promote public trust in science. If scientists lay their conflicts of interest on the table, the argument goes, they will be perceived as more trustworthy and will avoid the damage to trust that can result when an undeclared conflict of interest is later discovered.

But can we say for certain that openness about conflicts of interest always promotes public trust in science? Probably not. Raised public awareness of such conflicts may instead backfire and undermine the perception of science as an objective, trustworthy source of knowledge. Simple insistence on disclosure may also have the unintended consequence that scientists feel they have ‘done enough’ by disclosing a conflict of interest and do not consider its potential effects. Such uncertainties surrounding the effects of disclosure are reflected in the diversity of journal policies (Goozner et al., 2008; Krinsky & Rotherbuerg, 2001), and regularly debated in journal editorials (e.g. Stossel and Lee, 2008). Regardless of your own opinion on these questions, you should of course check and carefully follow any policies on disclosure that apply to you and your work, particularly when submitting papers for publication.

In spite of the contested effects of disclosure on scientist behavior and public trust, transparency remains valuable. Letting your stakeholders – be they peers, funders, editors, patients, journalists, or other readers of your publications – know about your conflicts of interest is a way of respecting their ability to form their own judgments. It gives them the opportunity to judge whether the conflicts are insignificant, warrant a more detailed investigation of your work, or, in their opinion, disqualify you from participating in line of research. Disclosure also communicates your awareness of the existence and potential consequences of conflicts of interest, and it helps to share the responsibility for evaluating and monitoring conflicts of interest across the scientific community.

Journals are not the only place where you can disclose conflicts of interest. Researchers can choose to list their conflicts of interest online,¹⁴ or in places where particular stakeholder groups will be able to access them: for example, in the case described in Box 2, Anjali’s research team could have posted a conflict of interest statement on a local community website. It is important to consider whether your disclosure is easy to find – having a list of your conflicts of interest in a PDF on a subpage to your personal webpage on a university website may make the information available in principle, but no one is ever likely to see it. On the other hand, if you want to make a public disclosure, it is also important to check with your supervisor or legal office whether there any

¹⁴ At University of Copenhagen this can be done in CURIS. See the university rules on external activities for details (listed in section 5).

restrictions on whether and how you do so. Of course, some interests do not require disclosure, particularly those are just a part of being a scientist in today's world (e.g. see John's case in Box 2).

Box 5: Rules of Thumb for Disclosure

- If you are uncertain whether an interest that you have presents a conflict, disclose it clearly. The Danish Code of Conduct for Research Integrity requires all parties to disclose “any conflicts of interest”.
- Deciding whether a financial conflict of interest is significant can be tricky. Journals may have clear guidelines on what should be disclosed, but otherwise the guidance is not entirely clear. A good rule of thumb is that you should disclose all interests except those that are so small or unrelated to your work that you cannot imagine anyone else (including a journalist) thinking they are relevant.
- In most circumstances, interests that apply to all scientists, such as the pressure to publish or obtain funding, need not be disclosed.

4.2 A culture of reflection: Talk about conflicts of interest

If you identify a potentially significant conflict of interest for you or for your research group, try to find a way to bring it up with your colleagues, including your supervisor if possible. Ask those around you: Do they agree that a conflict of interest exists and could it threaten good scientific practice? How might the conflict of interest cause suspicion of undue influence? Does anyone see a straightforward way to eliminate the conflict or does it arise from elements of your situation that cannot easily be changed? Who else could be called in to assist or advise?

Preliminary discussions help to ensure that action is taken quickly – but they also give those involved a chance to respond and potentially correct misunderstandings before official procedures are brought into play or accusations are made. If official rules or guidelines cover the situation, open, preliminary discussions will also help to ensure that they are applied quickly and effectively. Where there are no clear rules, or where the potential consequences lie in the grey zone of questionable research practices, discussion with colleagues becomes even more advisable and a key way of improving your own judgement (see also 3.3). In general, the habit of discussing the many competing interests that scientists deal with is a good one: it can help to raise awareness, empower people to raise specific cases, and potentially reduce the risk that conflicts of interest will have negative consequences.

To return to the case studies in Box 2, if conflicts of interest were regularly discussed in John's lab, his supervisor may have talked to him about the pressures that the need to get a high profile publication places on PhD students, preparing John to better handle his doubts. Or for Lone, if the research team had from the outset of the project discussed conflicts that might arise if preliminary findings failed to show what the funder hoped, others in the team might have been prepared to ask about the results and share the burden of deciding on next steps.

4.3 Restrictions on financial interests

As described in Section 2, financial conflicts of interest are considered highly likely to influence a scientist's ability to fulfil their primary duty and/or damage public trust in science. They therefore receive particular attention and need to be managed with care. Personal financial interests are sometimes managed by restricting the amount of money a scientist can invest in companies related to their research, the amount of money they can make 'on the side', or the intellectual and financial ownership of research results (see also Chapter 6). But who sets these restrictions varies – there are both national guidelines and institutional frameworks, and researchers involved in international collaborations need to take particular care to check that they are satisfying all relevant guidelines.

Professional financial interests, such as the need to obtain good, important or even specific results to satisfy funders or improve a scientist's chances of obtaining more funding, are less easily managed. Indeed, to some degree these pressures are ubiquitous. As John and Lone's case studies both show (Box 2), pressure to secure future financial support or employment can easily affect decisions about when and how to share results. In neither case is the *existence* of the conflict of interest something that could be eliminated – rather, in these cases researchers must often rely on other modes of management such as discussion and reflection (4.2) and disclosure (4.1).

4.4 Recusal

The Danish Public Administration Act (see Section 5) applies to all employees at the University of Copenhagen. It is a fundamental principle of this act that public employees must be impartial when they contribute to decisions on e.g. who should receive funding or be employed, taking only professionally relevant considerations into account. If employees have a conflict of interest – e.g. if a close colleague is on the shortlist for a job or grant – they are deemed ineligible and must step back or 'recuse' themselves from taking part (see also The European Code of Conduct for Research Integrity, 2011; p.14). In practice, it can sometimes be difficult to find members of evaluation or hiring committees with *no* conflicts of interest, particularly in small research fields (see The Danish Public Administration Act, §4). Other situations that may require recusal include certain types of additional or outside employment, when these are deemed likely to interfere with an employee's main duties.¹⁵

'Recusal' is a tool that can also be usefully applied to situations not covered by employment legislation; indeed, to any situation where a conflict of interest is considered highly likely to cause an actual or perceived bias in research. In the case studies of Box 2, Anjali could have decided to remove herself from the project, or at least to step back from any part of data collection and analysis where her private interest in the result could bias her work.

It is very important for PhD students trying to decide whether to eliminate a particular conflict of interest via recusal to get advice. You can discuss the matter with colleagues, your supervisor, with the faculty's Named Person, and where relevant with key stakeholders. In difficult cases, any

¹⁵ See <https://intranet.ku.dk/medarbejderguide/hr/ansat/bibeskaeftigelse/Sider/default.aspx> for details for employees at University of Copenhagen

decisions about the participation of individual researchers will ideally be taken by someone suitably qualified who is not involved in the relevant research project (Steneck, 2007; 78).

Box 6: Practical tip

Keep a record of the conflicts of interest you consider yourself to have, and of any financial interests outside of your primary employment, and update it regularly. A simple list saved on your computer will suffice.

This is a good way to stay aware of the issues surrounding conflicts of interest and how they may be affecting you, and it can be a useful focus in any discussions with your supervisor about, say, publication schedules. A regularly updated list can also make it quicker and easier to prepare full replies if you are asked about conflicts of interest (e.g. by a journal or a funding agency) (See Australian Code for the Responsible Conduct of Research, section 7.2.1.).

5. Selected laws, rules and guidelines

- The Danish Code of Conduct for Research Integrity
<http://ufm.dk/publikationer/2014/filer-2014/the-danish-code-of-conduct-for-research-integrity.pdf>
- The Danish Public Administration Act (Forvaltningsloven)
This law applies to all public employees in Denmark including those at the University of Copenhagen. Chapter 2 is particularly relevant. It focuses on situations where a public employee is considered ineligible due to a conflict of interest and thus must refrain from participating in decisions, discussion, and so on. <https://www.retsinformation.dk/forms/r0710.aspx?id=142955>
- The Danish Committees on Scientific Dishonesty - Guidelines for Good Scientific Practice
These guidelines focus on the importance of transparency where there are conflicts of interest, stressing the scientist's duty to declare them, especially in the context of publication of research. <http://en.fi.dk/publications/2009/the-danish-committees-on-scientific-guidelines-for-good-scientific-practice/>
- University of Copenhagen rules on external activities:
<https://intranet.ku.dk/employeeguide/HR/Conditions%20of%20employment/external%20activities/Pages/default.aspx>
<https://intranet.ku.dk/medarbejderguide/hr/ansat/bibeskaeftigelse/Sider/default.aspx>
- ICMJE Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals, 2013. (Vancouver Recommendations)
These recommendations include detail discussion of the disclosure of conflicts of interest. They have been taken up by many journals. <http://www.icmje.org/icmje-recommendations.pdf>
The form the ICMJE recommends authors to use to report conflicts of interest gives a sense of what they consider relevant. It is available here (see also Stossel & Lee, 2008 for discussion): <http://www.icmje.org/conflicts-of-interest/>

6. Test yourself questions

- What is a conflict of interest, and what kinds of conflict of interest do you think are most relevant to PhD students?
- How can conflicts of interest be damaging to science or scientists?
- How can you determine which conflicts of interest are significant enough to require action to manage them (e.g. disclosure)?
- Do you think scientists should disclose all conflicts of interest? Why or why not?
- Describe three types of conflict of interest that scientists in Denmark often face, what the potential consequences might be, and how they could be managed or eliminated.
- Which conflicts of interest do you currently have, and what consequences could they potentially have for your scientific conduct if they are not managed correctly?
- For each of the three cases in Box 2, say what action you think the researcher should take.

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8 Public Science Communication

Louise Whiteley¹⁶

Summary

This chapter addresses public science communication as part of the responsible conduct of research. The chapter begins by asking what public science communication is (Section 1). It then presents arguments for public science communication as integral to responsible conduct (Section 2), discusses various motivations for communicating (Section 3), asks whose responsibility it is to communicate (Section 4), and points to key factors in doing communication responsibly (Section 5). Doing responsible science communication is not just a matter of explaining scientific results in an accurate and balanced way. Communicating how science *works*, including the uncertainty that accompanies research findings, is crucial if we are serious about inviting public audiences to take part in conversations about scientific research and what it means for society. It is also crucial for researchers to be clear about their motives for communication, and consider how these may differ from those of media professionals and the publics they communicate with. The diverse media available today – from social media to public lectures or participatory events – make it easier than ever before to engage people with research, and allow researchers at every stage of their careers to participate. However, researchers still need to reflect carefully on when and how it is appropriate to communicate their own research, and about how they present themselves, their institution, and their expertise. The focus of this chapter is reflecting on why, how, and when to communicate, but practical tips and links to further guidance are also included.

1. What is public science communication?

Before we start discussing public science communication as part of the responsible conduct of research (RCR), we will step back for a moment and ask what it might involve. One of the most prominent forms of science communication is reporting by journalists, including specialist science journalists such as Lone Frank in Denmark or Matt Ridley in the UK. Giving an interview to a journalist can be a highly effective way for a scientist to communicate their research or to enrich news coverage with their expert commentary, but there are also many other possibilities for communicating in public. Different media facilitate different communication goals – for example, social media and public engagement events can allow researchers to come into more direct contact with publics¹⁷ and allow publics to get more actively involved.

¹⁶ The author would like to thank Peter Sandøe, Karsten Klint Jensen, Morten Hilgaard Bülow and Jeppe Berggreen Høj for comments, input, and editorial advice, and staff at Medical Museion including Adam Bencard, Thomas Söderqvist, Karin Tybjerg, and Nina Bjerglund Andersen for ongoing dialogue around approaches to science communication.

¹⁷ In the science communication research literature, rather than write about 'the public' scholars often write about 'publics' in the plural. This recognizes that there is not one homogenous public. Rather, there are groups with different attitudes, knowledge, and interests in scientific research. Many of these heterogeneous 'publics' have significant if non-traditional forms of expertise, e.g., patient organisations.

This chapter will take a broad perspective on forms of public science communication. Box 1 lists different communication media with examples, and Box 2 gives case studies of scientists who do public communication. Both demonstrate the diversity of media available, and Box 2 also demonstrates the diversity of roles scientists can play – from writing personal blogs about their daily work to being interviewed for TV, speaking at public events, and appearing on radio shows. For more examples, the University of Copenhagen’s online newspaper *Universitetsavisen* published a series of articles in 2014 about the University researchers with the most media mentions: <http://universitetsavisen.dk/videnskab/top-21-1-kasper-moller-hansen>

Box 1: A diversity of media forms for science communication

- Newspapers, news websites and news programs, often featuring prominent scientists. Scientists on the news sometimes talk about their own research, but often comment on news stories related to their broader expertise. For example, a political scientist commenting on elections or a plant geneticist commenting on protests about GM crops.
- Science magazines, e.g., *Wired*, *Discover*, *New Scientist*
- Popular science books, e.g., those by Richard Dawkins, Ben Goldacre, and Stephen Hawking
- Documentary films and radio programs, e.g., RadioLab (www.radiolab.org), Material World on BBC Radio 4 (www.bbc.co.uk/programmes/b006qyyb), or Hjernebassen on DR (www.dr.dk/pl/hjernebassen-pa-pl).
- Online videos produced by scientists, both serious and for fun
- Live webcasts of public talks, e.g., TED talks (www.ted.com/topics/science)
- Social media including blogs, Twitter, Facebook, Q&A sites, e.g., Science Blogs aggregator (www.scienceblogs.com), Reddit Science (www.reddit.com/r/Science)
- Museums and science centers, e.g., University of Copenhagen museums such as Medical Museum (www.museum.ku.dk)
- Science fiction or novels with scientific or biomedical themes, e.g., *Frankenstein* by Mary Shelley, *Saturday* by Ian McEwan
- Cafe Scientifique and discussion groups, e.g., Science & Cocktails in Copenhagen (www.scienceandcocktails.org)
- Science festivals, e.g., 24 hours, Golden Days, ESOF public programs (hosted by Copenhagen in 2014, www.scienceinthecity.dk), Guerilla Science (<http://guerillascience.org/>)
- Science comedy, choirs, and club nights, e.g., Copenhagen Science Slam (www.facebook.com/cph.science.slam)
- Theatre productions, e.g., Videnskabsteatret (www.videnskabsteatret.dk), Interior Traces (www.interiortraces.com)
- Consensus conferences and political consultation, e.g. GM Nation (www.gmnation.org.uk)

Box 2: Case studies of scientists doing public communication

- 1) Anja Cessi Andersen is a Professor of Astrophysics at the University of Copenhagen and does a lot of public outreach, particularly being interviewed for television and radio and at public events (<http://dark.dark-cosmology.dk/~anja/media.html>). By speaking at length, she can often deliver her message in her own voice, rather than always being filtered through a journalist's lens.
- 2) Ben Goldacre is a British doctor and epidemiologist who often comments on news stories, writes a newspaper column and blog called 'Bad Science' (www.badsience.net) which exposes flaws in biomedical research and in media reports of research. In doing so, he communicates how epidemiological studies work methodologically, aiming to equip his readers better to evaluate other reports of clinical research in the future. You can also find Ben Goldacre on YouTube giving talks at public science events such as TED (www.ted.com/speakers/ben_goldacre), and on Twitter as [@bengoldacre](https://twitter.com/bengoldacre).
- 3) Microbiologist Dr Rosie Redfield writes an 'open science' blog reporting the daily work in her laboratory at the University of British Columbia (<http://rrresearch.fieldofscience.com>). After reading a paper in *Science* claiming that a bacteria had been discovered that could live on arsenic rather than oxygen, Redfield was skeptical and repeated the experiment, failing to replicate the results. She reported the results on her blog, which was picked up by the scientific community and popular media, contributing to a retraction of the original study (see Wolinsky, 2011).

When thinking about public science communication, it is worth recognizing that many of the issues overlap with those of internal scientific communication. A peer-reviewed journal article can seem worlds apart from an article in a tabloid newspaper. However, both involve selecting what to include and in how much detail, and deciding whose perspectives are presented. Even when producing a peer-reviewed article, scientists inevitably omit a lot of what actually happened in the lab – such as failed experiments, changes in methodology, or alternative explanations of the findings. And unless publishing in a highly specialized or high profile journal, authors are often communicating to scientists from different fields and so have to simplify or explain technical terms. Whilst a lot *more* detail is omitted for a non-scientific audience, the job of translating from one 'language' to another is fundamentally the same. Gregory and Miller (1998, p.245) write;

"Scientists take for granted that the scientific paper is not literally true: it is not a blow-by-blow account ... But the scientific paper is truthful even though it is written according to a formula which deliberately distorts the literal truth in order to make the research accessible to other scientists. So popular accounts of science should not be viewed as somehow 'untrue', merely because they, too, have to leave out a lot and simplify what they include to match the expectations and abilities of their audiences"

Bucchi (2004) argues that we should therefore think of science communication as a continuum with highly technical scientific publications at one end and popular media at the other – in-between lie media such as science magazines, textbooks and detailed documentaries. Thinking in terms of a

continuum also highlights that there isn't a black and white boundary between popular and scientific communication, and reminds us that scientists consume popular media too.

2. Public science communication as part of the responsible conduct of research

In recent years governments, universities, and funders have placed more pressure on scientists to do public science communication. Or in other words, to engage more closely with the society that supports and will be affected by their work. Indeed, public engagement is now often seen as the third arm of the modern university, alongside research and teaching.

In Denmark, the University Law (Box 3a) and the Danish Code of Conduct for Research Integrity (Box 3b) both reinforce the message that communication and participation in public debate are central to good scientific conduct (see also Doubleday, 2009; Pickersgill, 2010; Meyer & Sandøe, 2012). However, courses and textbooks on RCR or research ethics rarely cover science communication. This leaves researchers with little guidance on why they might want to communicate, when they have a responsibility to do so, and how to communicate responsibly (Meyer and Sandøe, 2012). The present chapter addresses this gap, with a focus on early stage researchers.

Box 3: The responsibility of the university to communicate in public

1) Danish University Law (Uddannelses- og Forskningsministeriet, 2015), Chapter 1, Paragraph 2, Section 3 (translated by Jeppe Berggreen Høj):

“The University must as a central knowledge and culture bearing institution exchange ideas and competences with the surrounding society and encourage employees to participate in the public debate.”

2) Danish Code of Conduct for Research Integrity (Danish Ministry of Higher Education and Science, 2014b)

“Publication and communication are essential for enabling the research community to scrutinize and discuss research results. Thus, researchers have a right and an obligation to publish and communicate their results to the research community, to professional practitioners, and to society at large. Research can be communicated through various channels ranging from strictly professional contexts aimed at peers to more popular research communication aimed at a broader audience.

Although form, expression and level of detail may differ according to channels employed and audiences addressed, the standards for responsible conduct of research should always be respected when communicating research.”

3) Excerpt from ‘The Engaged University: A Manifesto for Public Engagement’ (UK National Coordinating Center for Public Engagement, 2010)

“Twenty-first century universities make a huge contribution to the life and success of the nation – through their teaching, their research, their students and their relationships with other organizations. In recent years, with government encouragement, universities have worked hard to strengthen their mutually beneficial links with the local and regional economy and business community. Now there is increasing recognition that higher education institutions can play an equally vital role in the UK’s community, intellectual and cultural life through their engagement with the public. It is a role that enables institutions not only to rediscover their roots as active contributors to positive social change but also to gain practical benefits of lasting value.”

One of the key norms of scientific research is that the knowledge it produces should be shared openly within the scientific community. This helps knowledge to progress by avoiding unnecessary repetition of experiments and opening research up to peer scrutiny, and allows potential applications of basic research to be explored as early and efficiently as possible. In Merton’s 1942 sociological study of the principles under which scientific institutions operate he describes openness or ‘communalism’ as one of four central norms; the idea that scientists should feel a sense of common ownership of the products of science (Merton, 1972). Contemporary formulations based on Merton’s work (e.g., Ziman, 2000) still include communalism, and whilst scientists often keep new results or novel techniques under wraps until they are published, the importance of publication in scientists’ lives indicates how central a principle communalism still is.

Meyer and Sandøe (2012) argue that this principle of openness should extend further, not just encompassing scientific publications read by other scientists but also encompassing communication via popular media. Or in other words, common ownership of research results should include those outside scientific institutions. If we don’t share research in public we leave people unequipped to deal with scientific controversies when they arise and exclude them from discussions about the future of research. Openness between scientists and publics can also help to facilitate the progress of research. For example, the translation of research into real world applications can be improved when the people who will use those applications are involved from an early stage. It is also worth noting that as science becomes ever more interdisciplinary and international, popular media are an important route for scientists themselves to learn about each other’s work and thus focus their efforts most efficiently (Research Councils UK, n.d.).

3. Benefits of public science communication

The arguments for public science communication being an integral part of RCR (see Section 2) invoke a range of possible benefits; on societal, institutional, and personal levels. This section breaks down these three levels in order to give a fuller picture of the roles science communication can play, and to encourage readers to reflect on which potential benefits might motivate their own

communication. As discussed further in Section 5.1, being clear about your reasons for communicating is key to doing it responsibly and well.¹⁸

3.1 Benefits to society

- *Democratic imperative:* Publicly funded research institutions rely on taxes, and should communicate with taxpayers how their money is spent. Even privately funded institutions rely indirectly on the infrastructure of a tax-funded democratic society. Setting aside economic arguments, research institutions produce knowledge that aims to affect society for the better. As such, they should arguably involve those who will be affected – though to what degree is a matter of ongoing debate (see e.g., Irwin, 2009; Bultitude, 2011).
- *Scientific citizenship:* If citizens are expected to engage with research and join in debates, they arguably need to know something about science and how it works. *What* exactly they should know is a matter of controversy – is it more useful for citizens to know scientific facts, understand methodologies, appreciate the social and economic contexts of research, or ponder the philosophical implications? (Gregory & Miller, 1998; Bell, 2010). Scientists can span these domains of knowledge, offering not just clear explanations of research findings, but also offering an inside view on the processes, uncertainties, and implications of research.
- *National prestige and economics:* The televised moon landing of 1969 was in part a celebration of the scientific and technological advances that allowed it to happen. As TV viewers around the world watched Neil Armstrong’s ‘giant leap for mankind’ they were also taking in a message about US power and prestige (Gregory & Miller, 1998; p.13). International EXPOs and science and technology fairs are also examples of how communicating research on the international stage enhances a country’s reputation, which can then attract future talent and investment in research (Gregory & Miller, 1998; ch.8).
- *Improved research translation:* Research institutions are increasingly asked to translate their research into practical (and profitable) applications. User research is an important part of this process and involves communicating about science with non-experts. In a wider sense, the more that research is part of public culture and the more that scientists listen to public responses, the stronger a basis there will be for designing applications in a way that will be both effective and socially acceptable (Stilgoe, Irwin, & Jones, 2006; Wilsdon & Willis, 2004).
- *Shared culture:* It has also been argued that science is part of a shared heritage and as such should be a widely accessible part of our culture, independent of educational goals (Bultitude, 2011) – similar arguments are made for other cultural domains such as classical music.
- *Public attitudes:* For scientists working in controversial areas, public attitudes can affect their ability to do their work and to obtain future funding. For governments, applications of research in areas such as agriculture, food safety, and social policy can also be hindered by public protest. Contributing to accurate media portrayals of controversial research, providing expert commentary, and participating in public debate can help combat hype (Cossins, 2014), nurture trust (Bultitude, 2011), and possibly prevent protest (Taylor, 2007). But enhancing public discussion of controversial research isn’t a guaranteed solution – it can also draw more attention to controversial areas and increase public anxiety.

¹⁸ Note that this section focuses on the motives of scientists and their institutions. Media producers – ranging from professional journalists to bloggers, artists, and museum curators – might have other motives for communicating, not least fascination, aesthetics, and entertainment.

It is also unclear how exactly public responses should be used. For example, how should we handle religious perspectives, what happens if different public groups disagree, and to what degree is it appropriate to let non-experts shape future research directions? To take a more cynical perspective, communication can also be used to control public reactions – for example by emphasizing the safety of new techniques or potential benefits of controversial research and downplaying the risks (see Irwin, 2009).

3.2 *Benefits to universities*

As mentioned in Section 2, universities are increasingly under pressure to engage with the society around them. Quotation c) in Box 3 is taken from the manifesto of the UK National Co-ordinating Centre for Public Engagement, which supports universities in improving their public engagement efforts. The last line highlights that the benefits should be mutual – both bringing practical benefits to the university and expanding the university’s positive social role. Some of these benefits are listed below (see also Bultitude, 2011).

- *Branding*: Communicating about research in popular media can increase awareness of a university, its staff, and funders. In other words, it is an important part of ‘branding’ the institution and thus increasing its competitiveness in attracting funding and investment.
- *Reputation and Trust*: Scientists participating in open communication, comment and debate can increase public trust and improve the university’s reputation in the wider community. Whilst openness can of course backfire if scandals and controversies come to light, being discovered to have hidden something is arguably more dangerous¹⁹.
- *Social Accountability and Responsibility*: Demonstrating social accountability is particularly important in a climate where universities are increasingly under scrutiny for their benefit to society. Social responsibility can be improved both by involving publics in research and its translation, and by making researchers more aware of social issues and public perspectives – both activities that involve communicating about science in public contexts.
- *Recruitment and Training*: Communication with the wider society can help to inspire and recruit future students and staff. Supporting researchers in taking part in public communication can enrich their work experience and provide valuable transferable skills

3.3 *Benefits to individual scientists*

The benefits to society (3.1) and research institutions (3.2) discussed above might seem irrelevant to individual scientists – or at least less pressing than their research. And scientists might also argue that the collective responsibility of the university to communicate doesn’t apply to them individually (Section 4). But there are also a range of individual benefits to taking part in public science communication (Research Councils UK, n.d.):

¹⁹ There is a similar debate around whether more disclosure of conflicts of interest will improve public trust or instead increase public attention to the potential impacts of conflicts of interest on researcher integrity, see Chapter 7.

- *Enhance your scientific CV:* As universities are under pressure to engage more with the surrounding society, experience in this area can be a bonus point on top of a good research and teaching record.
- *Build a career outside science:* For those young researchers who decide that a career in research is not for them, communication experience signifies valuable transferable skills. It can also lead to specific research dissemination or public engagement roles in e.g., universities, funding bodies and charities, and government research or education departments.
- *Improve your grant applications:* Whilst a minor part of an application, in highly competitive funding rounds when every point counts, a stand-out section on dissemination or public outreach can give you an edge. Previous experience is helpful, but so is being able to come up with original and thoughtful ways of communicating with public groups.
- *Improve your communication skills:* Intra-scientific communication such as writing journal papers or preparing conference presentations has more in common with public communication than you might think – both involve translation for an audience less expert than you (see Section 1). So practicing how to explain research in public will benefit your scientific writing too.
- *Make connections with other scientists:* Scientists are also part of the ‘public’, and as the use of social and online media increases, the boundaries between science communication for a general public and for interested experts are blurring (see e.g., Wolinsky, 2011; Andersen & Söderqvist, 2012). Communicating ‘in public’ can thus enhance your reputation and recognizability amongst other scientists too. It can also be a way of making direct connections with potential colleagues, collaborators and future employers (Research Councils UK, n.d.), especially through social media (Andersen & Söderqvist, 2012, p.10), and can e.g., lead to invitations to present your work in person.
- *Keep up with your field and its impact:* Many scientists read the front section of journals such as *Nature* and *Science* to keep up with developments in their field and with wider issues in science funding, governance, and careers. Keeping an eye on how your field is covered in popular media can be an extension of this process; part of a wider passion for research and how it shapes and responds to society. Noting what you do and don’t like about other media coverage of your field can also help you plan your own public communication work.
- *Have fun!* Lots of scientists who do public communication work do it because it is enjoyable; it’s a break from research and can make you feel more connected to the world outside the lab.

4. Whose responsibility is it to communicate?

The Danish Code of Conduct for Research Integrity states that university researchers have “a right and an obligation” to communicate (Box 3b). This doesn’t imply that all individual scientists have an obligation to communicate all of their research – the duty is a collective one, and therefore lies primarily with the institution. If researchers do want to get involved, particularly at an early stage of their career, their institutions should support them through a culture that values science communication and advises researchers on how to communicate responsibly (see Danish Ministry of Higher Education and Science, 2014b; Section 3.2 v. & vi.).

In Section 3.3 we listed positive benefits of doing public science communication for individual researchers. There are equally many reasons scientists give *not* to communicate. One of the main reasons scientists give for avoiding public communication is that they don’t have enough time (Royal Society, 2006, p.10). Researchers must of course balance a shared duty to communicate against other duties in relation to research, teaching, administration etc., and be aware of potential

conflicts of commitment. Scientists also often refer to it being the wrong time to communicate – e.g., to avoid being scooped or due to restrictive publication agreements with funders or industrial sponsors. And if scientists are asked to participate in public conversation about controversial topics, they may be worried about being drawn into a polemic or being misinterpreted. For example, in 2011 Professor of Political Science Marlene Wind made comments about a political agreement on increased Danish border control, and was accused of using her position as expert to air her personal opinions, resulting in her taking a break from media work²⁰.

Another response researchers might give to questions about why they don't do public communication is that it is the journalists' responsibility, not theirs. But when researchers are an expert in a field that is currently in the news, they may feel a duty to share their expertise and improve media coverage by e.g., giving interviews to journalists. Even as an early stage researcher, you are likely to be able to offer a reporter or public audience valuable insight into your research area. It is also worth thinking about the benefits of communicating more directly with public audiences. This can offer the researcher more control over the conversation, and without the strict length constraints of news articles, it can also allow researchers to give more of an insight into the 'behind the scenes' of how science works. In the past, only the most high profile or dedicated scientists would have spoken in their own voices, for example through televised lectures or writing popular science books. Today, public events and online and social media have massively expanded scientists' opportunities to communicate directly and take part in two-way public engagement, even at an early stage in their career.

Even if you decide not to communicate about your own research, communicating about research in general fulfils many of the same goals. For example, you can contribute to inspiring future scientists by talking about biology in a school or inviting students to visit your lab without mentioning sensitive details of your own studies. This also applies to researchers in highly abstract or technical areas, though it's worth remembering that the internet has opened up access to audiences for even highly geeky or esoteric subjects.

In sum, it is a duty of the scientific community and institutions to communicate with the wider society, but individual researchers are not obligated to communicate; they must decide when to contribute to this communal duty. In this chapter we cannot give a simple formula for deciding whether, when, and how to communicate, we instead introduce some relevant factors to consider.

5. How to communicate responsibly

If you have decided to communicate, how can it be done responsibly? The Danish Code of Conduct for Research Integrity states that “*Research results should be published in an honest, transparent, and accurate manner*” (Danish Ministry of Higher Education and Science, 2014b, see Box 3b), and the European Code of Conduct for Research Integrity (2011) states that “*In communication with the general public and in popular media the same standards of honesty and accuracy should be*

²⁰ A summary of the case with links to media coverage can be found on Wikipedia:
https://da.wikipedia.org/wiki/Marlene_Wind#Kontrovers_i_2011

maintained; any attempt to exaggerate the importance and practical applicability of the findings should be resisted.”.

These statements imply that a set of core values apply to all forms of communication, whether in scientific or popular media. However, it is important to acknowledge that what exactly honesty, transparency, and accuracy mean in practical terms depends on the context. Whilst researchers should always aim for honesty in public (and should certainly avoid *dis*-honesty), it is often impossible to be accurate in the same way for a popular audience as for your expert colleagues. This, as Gregory and Miller (1998) argued in the quotation in Section 1, does not make popular communication untrue – and it doesn’t mean we should give up and indulge in hype. Rather, it should encourage researchers to recognize the constraints of public communication and work as well as possible within them.

In the remainder of this section, we go through some key questions to consider when planning public communication, to help researchers make the most of the benefits it offers whilst also satisfying the demands of research integrity (5.1-5.5; summarized as a checklist in Box 4). These questions are not highly technical – they just require some reflection and common sense – and writing out concise answers to each one is good preparation for media work. If you are preparing for public communication activities your department or faculty’s communication office or media section can also help and advise you. There are also many practical guidelines, courses, and workshops to help scientists learn more about how journalists and other communication professionals work, and to prepare for interviews – see Section 7.

Box 4: Checklist of questions for responsible research communication

- 1) Reflect on your goals – why do you want to communicate, and what kind of relationship do you want to have with your audience? (see Section 5.1)
- 2) If you have a choice, which media will best match your goals? If you don’t have a choice about which media to use, do you need to adjust your goals? (see Section 5.2)
- 3) Which aspect(s) of research do you want to communicate about? (see Section 5.3)
- 4) Within the constraints of your medium, what is your key message? How can you honestly and accurately describe the novelty, importance, certainty, statistics, practical applications and ethical or societal implication of your research? (see Section 5.4)
- 5) Are there any requirements or restrictions (a) on what you communicate and (b) how you present your affiliation and expertise? (see Section 5.5)

5.1 Reflecting on your goals

Being clear about your goals is essential for planning communication effectively, and can help to avoid frustration and disappointment. Reflecting on the possible outcomes from a societal, institutional, personal, and audience perspective (see Section 3) can also draw your attention to potential unanticipated effects. For example, your primary goal may be to raise the profile of your department, but emphasizing how cutting edge your techniques are may also draw attention to uncertainty surrounding their safety or ethical status. Being clear about the goal of communication

can also help you to explain and defend your activities to others, and is crucial to a meaningful evaluation of whether the communication was successful (Research Councils UK, 2011).

One key dimension to consider when thinking about goals is what role you want the audience to play – do you want them to learn or to contribute? Or in other words, will you focus on one-way dissemination of information from a scientific expert to a public audience, or do you want to engage in two-way dialogue or public engagement? Box 5 gives a brief history of this key distinction, which also relates to the democratic arguments for involving publics in discussions about research outlined in Section 3.1. Of course, many communication activities will contain elements of both one-way dissemination and two-way engagement, and both are appropriate in different settings. What matters is being clear about your expectations and communicating them clearly to your audience or participants, helping avoid the frustration that can arise when e.g., scientific institutions say they will take on board public opinion and then fail to do so.

Box 5: What role should the audience play in public science communication?

For many scientists, the main goal of public communication is to increase public understanding of science (Royal Society, 2006, p.9). From this perspective, the task of the communicator is to translate technical details as accurately as possible into simple language; to disseminate information. But to think of communication as dissemination can also imply that it only goes in one direction: that the listener has nothing to say in return. This has been referred to as the ‘deficit model’; assuming that the public is deficient in knowledge, and that good science communication will solve the problem. The deficit model also tends to assume that the public’s *attitudes* are deficient, and that knowing more science will make them feel more positive towards research and researchers – assuming that ‘to know it is to love it’.

In the late twentieth century there was a widespread perception that public trust in science had been damaged e.g., by the atom bombs of World War 2, and governments and scientific organizations instigated explicit science communication programs in response. These programs tended to be grounded in the deficit model and focused on increasing public knowledge. Towards the end of the century ongoing public protest around issues such as GM crops, BSE, and vaccines suggested that this wasn’t having the desired effect and sociological studies of scientific controversies emphasized the failure of the deficit model as well as its failure to acknowledge the democratic arguments outlined in Section 3.1. The conclusion taken up by government and scientific institutions around the turn of the century was that scientists should ‘engage’ with publics rather than lecture them; thinking of them as scientific citizens who might inform and shape as well as consume and appreciate science (see e.g., Taylor, 2007; Danish Ministry of Higher Education and Science, 2014). For more detailed accounts see e.g., Irwin (2009), Broks (2004), or Wilsdon & Willis (2004).

Public engagement formats range from informal discussions, creative activities, and crowd-sourced research (Davies et al., 2009) to formal consultation exercises set up to gather public perspectives on controversial issues (there is a strong tradition in Denmark of this kind of work, see e.g., Horst, 2008). Social media are a key medium for two-way engagement, as they are fundamentally structured to invite reciprocal communication and break down barriers of expertise – although this

also presents new problems with deciding who to trust (Wolinsky, 2011; Mandavilli, 2011; Andersen & Söderqvist, 2012). In practice, it can be hard to draw a clear line around one-way vs. two-way communication, many forms of communication lie somewhere in-between, and it is surprisingly difficult to produce genuinely reciprocal dialogue (Irwin, 2009; Broks, 2004).

When thinking about your goals, it is important to recognize that communication professionals such as journalists or university media officers have different goals, duties, and constraints. For example, journalists may consider it their duty to report how basic biomedical research is relevant to patients whilst the scientists they interview consider it their duty to downplay how close we are to practical applications. Understanding and respecting each other's professional goals can help the diverse players in the science communication landscape make the most out of each other's platforms and expertise. To continue the example above, if you respect a journalist's need to report on the clinical relevance of basic biomedical research you can prepare an answer that clearly emphasizes the uncertainties and timescale of clinical translation. There is of course always a risk that a journalist will misquote, misrepresent, or misunderstand you, but this is often a risk worth taking. You can also reduce the likelihood of being misrepresented by preparing well for interviews and by requesting to read a quote or full article before publication, if the journalist's timescale allows.

5.2 Matching the media to your goal

Once you are clear about your goals, consider which media would best help you fulfil them. For example, if you want to encourage young people to take part in democratic debates about the use of cloning technology, a discussion activity may be more effective than a lecture. Or if you want to get as much attention as possible for a high profile result from your lab, working with the university press office to get the national newspapers interested may be better than writing a detailed blog post about methodology (though the impact of a blog post going viral shouldn't be underestimated).

Of course, sometimes the medium is decided for us – if a newspaper calls for a quote about your recently published *Nature* paper you'd be unlikely to turn it down in favor of using Facebook. If the media is decided for you, you may need to adjust your goals. For example, you're likely to be frustrated if you aim to communicate a nuanced picture of the uncertainty surrounding the future trajectory of research by giving a quote over the telephone (see Science Media Centre, 2015 for top tips on working with the news media).

5.3 Communicating different aspects of science

At several points in this chapter we have suggested that if we want public audiences to engage in meaningful discussions about research we need to communicate how science *works* not just the results that come out at the end. There are several reasons for this. First, science is always 'in the making' (Shapin, 1992) – a scientist should never express 100% certainty that a particular finding will hold forever. More likely, they will admit to some uncertainty over how future experiments will refine or revise current knowledge. Communicating about this uncertainty is a difficult task

(see Science Media Centre (2012) for some practical tips), but it is worth the effort. For example, someone who has read changing advice about drinking during pregnancy might think that scientists are either lying or that research is unreliable. But if they understood that certainty about the effects of alcohol evolves over time, and were given information about the levels of certainty attached to current recommendations, they would then have a firmer basis for deciding how to utilize those recommendations in their own lives.

Another reason for communicating about the processes and methodologies of science is that this kind of knowledge is generalizable. If people understand how clinical trials work, for example, they can apply this knowledge to future media reports about other trials. And finally, if we are serious about doing two-way public engagement that invites audiences to participate in discussions about research, some knowledge of methodology is essential. ‘How science works’ most obviously refers to methodology or theory of science. But it can also refer to social and ethical aspects of science, for example how funding and safety legislation works or ethical debates surrounding particular techniques. Communicating about these wider aspects of research also contributes to a culture where people are equipped to take part in debate; to act as scientific citizens.

It is important to note that this section has focused on which aspects of science *scientists* would like to communicate about. If we take arguments for two-way engagement seriously, we should also be asking what aspects of science are important and interesting from the perspective of the public groups we are trying to engage (Turney, 2003; Broks, 2004; Bell, 2010). Turney (2003) argues that rather than deciding in advance which bits of knowledge, methodology, and social contexts people need to know, we should focus on situations where science is relevant to their lives or where they are genuinely being invited to participate, and then communicate the information that is meaningful, relevant, or interesting to them in those contexts. The news media often claim to reflect ‘public interest’, covering stories that are of interest to their audience, but they also shape those interests.

5.4 Novelty, importance, certainty, statistics, and practical applications

In attempting to communicate “*in an honest, transparent, and accurate manner*” (Danish Ministry of Higher Education and Science, 2014b) there are several common pitfalls that relate to the temptation to exaggerate the importance of research findings. This temptation can be strong when your goals include increasing the public profile of your work or institution, and is exacerbated by the drive of many media outlets to produce ‘big splash’ stories. Making a list of phrases that accurately describe the novelty, importance, certainty, and practical and societal relevance of your research is good preparation for any communication activity (see *Guidelines for Scientists on Communicating with the Media* (2006) for more details and other practical tips):

- *How novel* are your findings? How do they relate to other work in the field? Do they contradict an accepted view or introduce a new hypothesis?
- *How important* are your findings? For example, do they resolve a gap in our knowledge, provide a missing technique, or promise to lead to an important practical application?

- How *certain* are you about the results? What are the sources of uncertainty, and are there experiments in progress that will help to confirm, refute, or revise your findings? How accepted are your findings by other scientists in your field?
- Do your results include a *probability* or do you need to communicate a level of *risk*, particularly in relation to health? If so, be very careful how you present these statistics and consider how to make them meaningful to a public audience (Science Media Centre, 2013).
- What are the potential *practical applications*, how close are they, and what factors stand in the way of progress? Relatedly, are there any *ethical or societal issues* associated with your research that you may be asked about or want to communicate?

5.5 Restrictions, requirements, and affiliations

University of Copenhagen legislation supports scientists in their freedom to communicate about research (see Box 3). However, there may be specific restrictions on when you communicate, as well as on what exactly you say. These might come from your supervisor or colleagues, in which case they can often be negotiated. Restrictions may also come from funders, sponsors, or professional bodies or from a journal embargo that prevents you discussing a paper before it is published. As a researcher you may also wish to adjust the timing of communication to avoid being scooped. If you have any concerns, check with your supervisor, funder, or other parties whose interests may conflict with your own (see Chapter 7 for a discussion of how to define and handle conflicts of interest).

There may be requirements as well as restrictions when you do public communication. For example, a funder may require that you mention them or your university may require you to include a link to a media enquiries page whenever you write online about your research. There may also be rules about when you present yourself as an employee/representative of your institution. Again, check with your supervisor or media department if you are unsure.

Finally, it can be unclear how to present your expertise. Scientists sometimes worry about not being experts outside their own specific research niche, but even in a broader research context your expertise is likely higher than those talking to you. On the flip side, some scientists offer opinions on the implications of their research e.g., for societal or ethical issues, that step well outside of their expertise. To tread this fine line responsibly, don't be afraid to discuss topics outside your specific research niche, but be clear about the limits of your expertise and when what you are saying is backed up by evidence.

6. Test yourself questions

- Give three reasons for doing public communication from a societal perspective, three from a university perspective, and three from the perspective of an individual scientist. Which do you find the most convincing and why?
- Describe two or three motivations for communicating science to the public from an individual researcher's perspective, and for each one discuss whether there are any conflicts of interest involved.

- Why is public communication included in a textbook and course on RCR? Do you agree that it should be?
- Describe the difference between top-down dissemination of scientific knowledge, and two-way public engagement. Discuss some of the reasons for engaging the public in dialogue.
- What roles can social media play in science communication?
- Discuss whose responsibility it is to communicate about scientific research in public, and how you think the individual scientist's and the university's responsibilities differ.
- What does it mean to do public communication responsibly?
- How does scientific communication relate to public communication?
- As a researcher, what challenges might you face in talking to journalists? Give four examples of questions you should prepare to answer before giving an interview.
- Discuss the role of public communication in establishing public trust in science.

7. Selected guidelines and practical advice

Section 5 summarized some key points to consider and prepare before doing public communication work – the guidelines below give more details. They are split into general guidelines and practical tips for science communication (7.1) and for using social media (7.2), plus some suggestions for courses and workshops if you are interested in learning more (7.3).

7.1 Guidelines on communication and public engagement

- *Guidelines for scientists on communicating with the media.* The Social Issues Research Centre (SIRC) and ASCoR. September 2009. Online access: http://www.sirc.org/messenger/messenger_guidelines.pdf
- *Communicating science: "A scientists survival kit".* By G. Carrada. European Commission Community Research. 2006. Online access: http://ec.europa.eu/research/science-society/pdf/communicating-science_en.pdf
- Science Media Centre UK. Publications for Scientists. <http://www.sciencemediacentre.org/publications/publications-for-scientists/> *These short leaflets offer practical tips for a range of scenarios, including giving interviews, communicating risk and uncertainty, and talking about animal research and peer review.*
- UK National Coordinating Center for Public Engagement. The Engaged University: A Manifesto for Public Engagement. 2010. <http://www.publicengagement.ac.uk/why-does-it-matter/manifesto>. *See also case studies and practical guidance on the same website.*
- Research Councils UK. Resources for public engagement. <http://www.rcuk.ac.uk/pe/guides/>

7.2 Guidelines on social media communication

- Social media: A guide for researchers. International Centre for Guidance Studies. <http://rinarchive.jisc-collections.ac.uk/our-work/communicating-and-disseminating-research/social-media-guide-researchers>
- Webicina Social Media Course, focusing on medicine: <http://thecourse.webicina.com/>

- AAAS Communicating Science Online: <http://www.aaas.org/page/communicating-science-online>
- Bik, H.M., & Goldstein, M.C. (2013). An Introduction to social media for scientists. *PLoS Biology*, 11(4), e1001535.
- Superfund's list of social media resources and courses (focused on the US): http://superfund.oregonstate.edu/apha-roundtable-communication-strategies#.VLwiUmTF_fb

7.3 Courses and workshops

In Denmark:

- Videnskab.dk does 1 day courses: <http://videnskab.dk/om/kurser-i-kommunikation-og-formidling>.
- The newspaper *Information* runs a longer medieskole course for PhD students, which happens in the spring as part of their 'PhD cup' program: <http://phdcup.dk/informations-medieskole/>

In the UK:

- 1 week Science Communication Masterclass at the University of the West of England: <http://www1.uwe.ac.uk/research/sciencecommunicationunit/trainingandshortcourses/masterclass.aspx>
- The Royal Society has 1 day courses and a 2 day residential: <http://royalsociety.org/training/communication-media/>
- The British Science Association runs a 'Communicating your Science' workshop for scientists: <http://www.britishtscienceassociation.org/science-society/communicating-your-science-workshops>
- Sense about Science runs 'Standing up for Science' media workshops for early career researchers across the UK: <http://www.senseaboutscience.org/pages/upcoming-standing-up-for-science-media-workshops-.html>

Distance learning:

- The Open University has a postgraduate course in science communication called 'Communicating science in the information age': <http://www.open.ac.uk/postgraduate/modules/sh804>

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Since 2011 it has been mandatory for all new PhD students at the University of Copenhagen to take a course in Responsible Conduct of Research (RCR). The present book will serve as a textbook for the courses held at the Faculty of Science and at the Faculty of Health and Medical Sciences.

The book thus aims to give an accessible presentation of what PhD students are supposed to learn about RCR; to present a clear and consistent terminology; and to focus on the way RCR is dealt with in Denmark and at the University of Copenhagen. The intended readers are from two faculties where the large majority of research falls under the umbrella of the natural sciences, broadly construed.

The book can also be of use to other scientific staff at the University.

UNIVERSITY OF COPENHAGEN
DEPARTMENT OF FOOD AND RESOURCE ECONOMICS

ROLIGHEDSVEJ 25
DK-2500 FREDERIKSBERG C
DENMARK

TEL: +45 3533 6800
E-MAIL: IFRO@IFRO.KU.DK
WEB: [HTTP://IFRO.KU.DK/ENGLISH](http://IFRO.KU.DK/ENGLISH)

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